AERATOR FOR MECHANICAL FILTER PLANT AT WINCHESTER, KY.

By Leonard Metcalf, Assoc. M. Am. Soc. C. E.*

In Engineering News of Feb. 21 there was published an interesting description by Mr. Richard D. Chase, Assoc. M. Am. Soc. C. E., of the slow sand filtration plant at Superior, Wis, of which Mr. Chase was Resident Engineer during construction. In that article was given a description of an aerator designed for that plant under direction of Mr. Allen Hazen, M. Am. Soc. C. E., who was the engineer for the whole purification works.

FIG. 1. GENERAL VIEW OF WATER AERATOR, WINCHESTER, KY.
Wm. Wheeler, M. Am. Soc. C. E., Engineer.

The accompanying illustrations show another aerator, built some months ago for the Winchester (Ky.) Water Co. after designs by Mr. William Wheeler, M. Am. Soc. C. E., of Boston, which appears to the writer meritorious and of possible interest to other engineers.

The conditions of the problem at Winchester were somewhat different from those which Mr. Hazen had to meet, in that the water flows by gravity from the impounding reservoir, on the stream forming the source of supply, to the aerator, and thence through the battery of three Jewell mechanical filters direct to the pumps. Some form of controlling device was therefore necessary to limit the rate of flow through the aerator to the draft of the pumps.

In other respects the designs chance to be similar, except for the fact that Mr. Wheeler has located the perforations first on the inside, then on the outside of the successive trays, so as to obtain further aeration and agitation of the water by a lateral motion in a thin sheet across each tray.

The aerator is so clearly shown by the illustrations, Figs. 1 to 3, as to make description unnecessary. The following facts, however, are pertinent:

The aerator is not necessary when the reservoir is full and the water is wasting over the dam, but only in times of low water in the summer, when the tributary streams, excepting a few springs, have dried up and the storage is drawn upon. Then trouble is experienced with algae and other organic growths.

As the water flows by gravity from the reservoir to the aerator, in order that the head of water on the pumps may not be unnecessarily sacrificed, provision has been made for adapting the aerator to the height of water in the reservoir. This is accomplished by varying the length of the aerator stand-pipe by removing sections thereof as the water in the reservoir falls, thus successively throwing out of commission the top pan, then the second pan, and even the third and fourth, if it should ever be necessary. It will be noted that in the view, Fig. 1, the top pan is out of commission.

The aerator is designed for a rate of flow of 750,000 gallons per day, though this quantity may be considerably exceeded, if desired, causing only an increase in the depth of water in the trays.

The trays are made of 3-16-in. wrought iron, each punched with 960 holes 5-16-in. in diameter, and subsequently galvanized with the other parts. The flaring nozzle and adjustable cone, shown in the cross-section, in Fig. 1, are made of composition metal, carefully turned. The float, Fig. 3, is made of copper; and the stand-pipe of wrought iron, galvanized.

*14 Beacon St., Boston, Mass.

THE NEW PUMPING PLANT OF THE PENNICHUCK WATER-WORKS, NASHUA, N. H.

By F. W. Dean, M. Am. Soc. M. E.*

(With two-page plate.)

The Pennichuck water-works at Nashua, N. H., are owned by a private company which supplies the city of Nashua with water. The supply comes from a number of ponds, two of which are near the pumping station. The outlets of these ponds empty into the Merrimac River.

At the outlet of each of the two ponds referred to there is a dam, and there has been for many years a water-driven pump just below each. Besides these pumps, there are two auxiliary steam pumps for use when the supply of water for power purposes is insufficient.

Quite recently springs have been discovered and developed along the shore of the lower pond, into which they discharge, and as long as the upper pond does not discharge into the lower, the people of Nashua enjoy a supply of water as clear and wholesome as can be found. The supply of spring water is usually sufficient for the needs of the population, as all the mills pump their own water for steam making and other manufacturing purposes from the Nashua River.

The company wished to increase the capacity of their water-driven pumping plant, and through the sagacity of the president, Mr. John F. Sa[illegible], of Nashua, the scheme was originated of at the same time preventing the contamination of the spring water in the lower pond by water from the upper, and of rendering the water power [illegible] as efficient as before, and thus so economizing the water to be used for power that the steam pump would be used for much less time during the year than heretofore.

These objects were accomplished by combining the heads of the two ponds by means of a steel penstock running from the upper pond to a point just below the lower, and large enough to convey water for power, and flood water in addition. Thus, two heads of 30 ft. were combined into one of 60 ft., and the lower pond has become a reservoir for spring water.

The engineering for these changes was entrusted to the writer's firm, which designed the head gate, penstock, pump, building, and the widened and deepened tail race. The head gate, rack, and the pump were built by the Portland Co., of Portland, Me., the penstock by the Stewart Boiler Works, of Worcester, Mass., the water wheel by the Holyoke Machine Co., of Worcester, Mass., and the buildings by a local contractor. The work on the tail race was done by the company.

The diameter of the penstock, which is some 1,400 ft. long, is 6 ft. from the head gate to the branch for the water wheel, then tapers to 4 ft. at the waste gate, and is thence 4 ft. in diameter to the end of the waste discharge. The steel plates of which the penstock is made go entirely around, and all joints are single-riveted lap. All holes were punched small and drilled to size in place, but as the contract was let at a time when prices were lowest, the finished penstock was very cheap. It was painted with the Bitumastic Enamels Company's preparation.

The supply to the water wheel is controlled by a 48-in. gate close to the wheel case within the house, and the waste gate is of the same kind, located in a small house nearby. The water wheel is a single 21-in. horizontal bronze wheel, making 400 revolutions per minute. It was of the usual commercial type and was necessarily located below the pumps. The cost of a special design of slow rotating wheel that might be direct-connected to the pinion shaft precluded such an arrangement, even if it had been otherwise desirable, and yet the commercial speed of 400 revolutions per minute presented a problem in speed reduction between the wheel and pumps that was, on first thought, somewhat embarrassing. The capacity of the pumps was to be 6,000,000 gallons in 24 hours, and it was determined to use a stroke of 3 ft. and 33⅓ revolutions per minute. The problem, then, was to reduce 400 to 33⅓ revolutions per minute. To do this wholly with gears invited trouble and noise, and it was finally decided to reduce from 400 to 100 revolutions with a belt, and from 100 to 33⅓ with a pinion and gear. To drive a large pump by a belt was to the designers wholly novel, but it was argued that a belt is amply capable of driving anything, provided it is wide enough and thick enough, and provided there is ample flywheel effect in the system. Here the matter of judg-

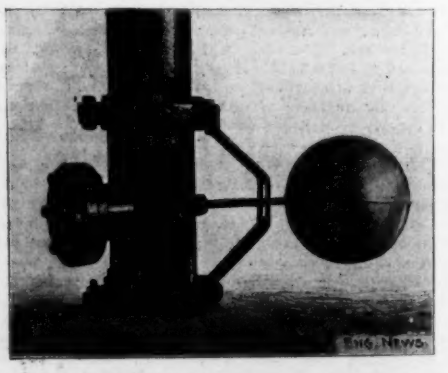

Fig. 3. View of Ball Float for Cone Adjuster in the Aerator at Winchester, Ky.

*Of the firm of Dean & Main, Mechanical and Mill Engineers, 53 State St., Boston, Mass.

ment entered as to the proper size of the belt. It was decided to use a 4-ft. pulley on the water wheel shaft and a 16-ft. pulley on the pinion shaft, thus making the belt speed 5,027 ft. per minute. A 30-in. triple leather belt was used and it has been perfectly successful from every point of view.

The pump is used for direct fire service, as well as for pumping into the mains against the reservoir head. The fire head is about 80 lbs., and the regular head 55 lbs. The pump has been tested by pumping at a 6,000,000-gallon rate against 120 lbs. This was done by pumping into the reservoir through an old 16-in. main about 6,000 ft. long. The regular main used is 24 ins. in diameter. The pump horse-power for 6,000,000 gallons is 154 for domestic service, and 212 for fire service. The pump runs so quietly at all speeds, and is so massive that it can safely operate continuously at a higher rate of speed than 33⅓ revolutions per minute.

There are two pumps operated by cranks at right angles. On the crank shaft there is a 12-ft. mortise gear, operated by an all-iron pinion 4 ft. in diameter, the width of teeth being 21 ins. The teeth are cut to run without back lash.

The pumps are built up of small pieces bolted together in order to have small breakages, if any should occur. The novel construction was used of having the valve plates of steel castings entirely separate from the other pump castings. The idea of conical pistons, so much used in marine engines, was adopted for these plates. The pump valves are of rubber 3½ ins. in diameter, and the springs are of phosphor bronze bearing directly on the rubber. The velocity of the water is 2.35 ft. per second through the minimum waterway. The pump plungers are pointed and are finished clear to the points. There is an air chamber on each end of each pump, all connected by a 3-in. pipe. They are charged by an air pump operated by a crank pin in the end of the pinion shaft.

The water is received by the pump under a head of a few feet through a main partly 20 ins. and partly 30 ins. in diameter. Near the edge of the pond, in the suction system, there is a screen-house provided with a gate for shutting off the suction. Connection is also made between the screen-house and the penstock for supplying the pump with water from the upper pond in case it should be necessary to draw off the lower pond.

The suction is received in a complete circuit by both pumps, and there is an air chamber located on the middle of the loop back of the pumps. This is also connected with the air charging pump.

The pumps are supported on columns at their back ends and by connection to the bed plates at the crank ends, thus leaving an open space below. The bed plates are massive castings of box section resting on the foundations throughout their length. The guides are bored, and the pedestals have adjustable 4-part boxes. The shafts, crank and crosshead pins, and plunger rods are forged steel, and the crossheads and cranks are of steel castings.

The mortise gear is cast in halves and held together by bolts and wrought-iron rings shrunk on. The teeth are of young hickory, and it will be observed that the rim of the wheel is made of box form so as to show only the working ends of the teeth, and thus avoid the scraggly appearance characteristic of such wheels in general.

The flywheel has a 32-in. face, and is 16 ft. in diameter, the rim speed being, as before stated, 5,027 ft. per minute when running at the normal speed of 100 revolutions per minute. The company were anxious to have a specially safe wheel designed, and it was decided to build the wheel up of small pieces. The hub is a single casting forced on the shaft by a tapered fit and keyed on. After the keys were driven, wrought iron rings were shrunk on, as shown by the drawings. The arms are separate castings, as well as the ring segments. They were faced off at both ends in a lathe, and were made to enter bored holes in the hub. At the hub they are held by studs screwed in unusually deep. At the rim end they are bolted by ream bolts passing entirely through the rim. The rim divisions are made at the ends of the arms, and the segments are of box girder form. These segments are bolted together in the middle of the width by four free bolts and are secured to each other also by rings shrunk on projections on the sides.

The principle on which the wheel was designed is that it was to be safe if the fastenings between the rim segments should all get looses at the same time, thus throwing all of the strain from centrifugal force on the arms and their fastenings. It was also to be safe if the arm fastenings should get loose and the arms become merely distance pieces, the rim under such a condition standing the strain of the centrifugal force. The outboard pedestals have been made very heavy and are provided with 4-part boxes having side-wedge adjustments.

The pump has been in operation since October 1, 1900.

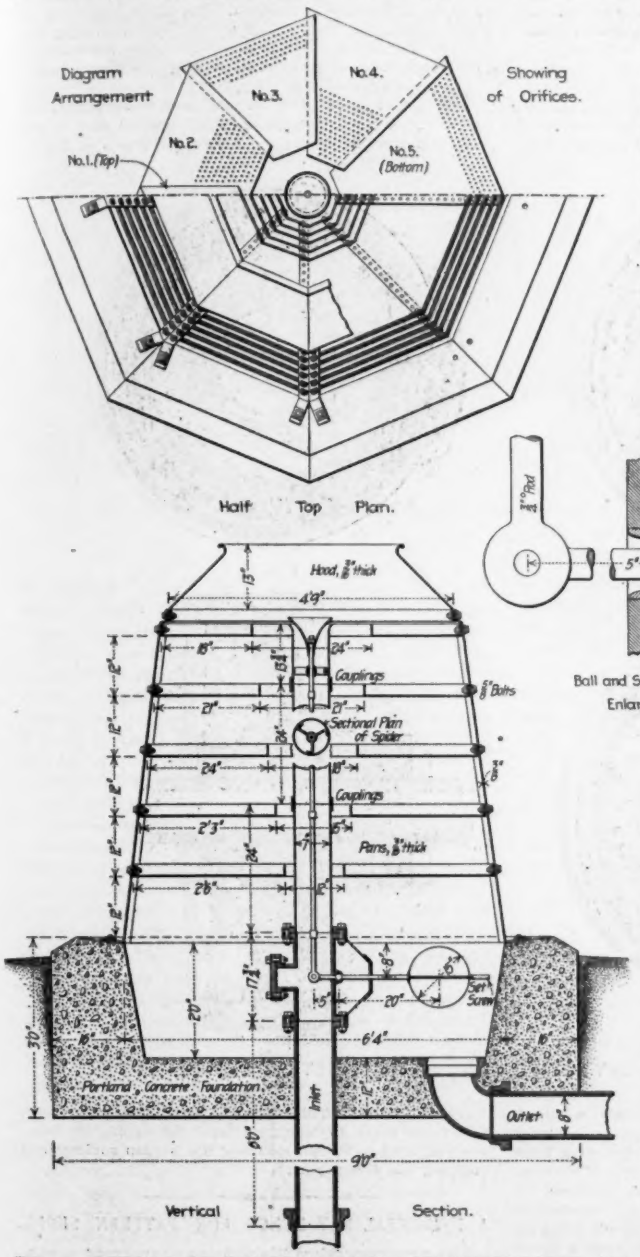

FIG. 2. DETAILS OF WATER AERATOR AT WINCHESTER, KY.

IS THE CONTINUOUS REPAIR SYSTEM THE MOST ECONOMICAL FOR MACADAM ROADS?

By Halbert Powers Gillette.*

As macadam roads are almost a century old, it may seem that little remains to be learned concerning their construction and repair. As a matter of fact, however, the introduction of the rock crusher and the steam roller within recent years has radically altered the conditions and methods of macadam road construction and repair. What was good practice in the day of Macadam may therefore, be very poor practice to-day. English and French authorities on road construction say that repairs to macadam should be made continuously, and that their experience has proved that the continuous system of repairing is cheaper than the intermittent system. While they may be right, one should ascertain just how work under both systems is conducted before accepting their conclusions as applicable in all cases.

As nearly as I can learn, the method of intermittent repairs seems to have been to let the pavement go until badly rutted, then loosen the old crust with hand picks, spread over it a thin layer of new metal, and roll until bound. I can find no detailed statement of the cost of labor and rolling by this method, but it must have been high at best.

The following, taken from my time books, show the actual cost of resurfacing a macadam road over a mile long. The road was worn unevenly, but as it still had sufficient metal left, very little new metal was added.

The roller used was a 12-ton Buffalo Pitts, provided with steel picks on the rear wheels. It required 80 hours of rolling with the picks in to break up the crust of a surface 19,400 sq. yds. in area, or 240 sq. yds. were loosened per hour. The crust was exceedingly hard and at times the picks rode upon the surface without sinking in, so that a lighter roller would probably have been far less efficient. In fact a 10-ton roller had been used a few years previous for the same purpose at more than double the expense per sq. yd., I am told. The picks simply open up cracks in the crust to a depth of about 4 ins. and it is necessary to follow the roller with a gang of laborers using hand picks to complete the loosening process. The labor of loosening and spreading anew the metal was 1,880 man-hours, or a trifle more than 10 sq. yds. per man-hour. About 60% of this time was spent in picking and 40% in respreading with shovels and potato hooks.

After the material had been respread, a short section was drenched with a sprinkling cart, water being put on in such abundance that when the roller came upon the metal, the screenings which had settled to the bottom in the spreading process were floated up into the interstices. The roller and sprinkling cart were engaged only 63 hours in this process, or 300 sq. yds. were rolled per hour, an exceptionally fast rate. The rapidity of rolling was due to four factors: 1. The great abundance of water used, the haul being very short. 2. The unyielding foundation (telford) beneath. 3. The abundance of screenings and fine dust, the road not having been swept for some time. 4. The great weight of the roller, which was run at a high rate of speed. I am not prepared to say that longer rolling would not have secured a harder surface, but I doubt very much whether it would. The metal, I should add, was hard limestone. Summing up we find the cost of

*Rochester, N. Y.

resurfacing this road per sq. yd. to have been as follows:

	Cts. sq. yd.
Picking with roller at $1 per hour	0.4
Picking by hand labor at 20c. per hour	1.2
Respreading by hand labor at 20c. per hour	0 8
Rolling with roller at $1 per hour	0 33
Sprinkling with cart at 40c. per hour	0 13
Foreman 143 hours at 30c. for 19,400 sq. yds	0 44
Total	3 30

At this rate a macadam road 16 ft. wide can be resurfaced for little more than $300 a mile. The frequency with which such resurfacing is necessary will, of course, depend upon several factors, chief of which are the amount of traffic and the quality of road metal. I should say that five years would not be far from the average for a country road built of hard limestone. Unless the road has had an excess of metal used in its construction, new metal should be added at the time of resurfacing to replace that worn out.

I am unable to see how any system of continuous repair with its puttering work here and there can be as economical as work done in the manner above described. I would not be understood, however, as favoring an entire neglect of the road between repair periods. At times of heavy rains and snows, ditches and culverts need attention and there should be some one whose duty it is to look after such matters. What I do question is the economy of having a man continuously at work putting in patches upon the road. In comparing one class of pavement with another it is customary to assume that because macadam, for example, wears three or four times as fast as brick therefore its maintenance will be correspondingly great. This I believe to be erroneous. I have in mind a brick pavement which in ten years has worn down about ¾-in., while a limestone macadam on the same street has worn about 3 ins. as an average. The brick pavement is, however, so unevenly worn that its life is but a few years more at best, and when taken up the remaining 3 ins. of brick will be valueless. The macadam can be economically resurfaced at any time, and all that is lost is the comparatively cheap stone which has been worn out for the upper 3 ins.

In conclusion, I would caution American engineers against accepting unquestioningly the generalizations of English and continental engineers, as we may be working under quite different conditions.

A NEW FRICTION CLUTCH.*

By Thomas Henry Smith.†

In all mechanical clutches, except the one here described, it is essential, in order to obtain the required pressure, either that one-half of the clutch must slide on the shaft, or else a sliding sleeve or collar must be used to actuate the levers and toggles, which push or pull the friction surfaces into contact. The power required to do this is always antagonistic to the driving power, and, in large-sized clutches, hand wheels have to be used with worms or gears to force the friction surfaces together, until the toggles pass the center, which passing always lessens the grip or contact.

The sliding of one-half of the clutch on the shaft is objectionable, because this loosely fitting part wears the splines through which the load is driven. Then it is difficult to keep the ends of the shafts in alinement, and this makes some clutches inoperative. The movement of the sliding sleeve or collar is undesirable, because the stationary ring which is recessed into the collar, and to which ring the forcing lever is attached, wears out and is liable to heat, while the collar throws oil and is a nuisance generally.

The levers and toggles, being of necessity outside the clutch, are unsightly, dirty and dangerous, and in no clutch that I know of can they be tightened in case of slipping without stopping the driven shaft, and in one clutch that I had, the driving shaft also had to be stopped, which meant shutting down the engine and stopping the whole mill.

In the Philips clutch, instead of the resistance of the driving shaft having to be overcome, and the friction surfaces being forced together by an enormous outside pressure, the clutch harnesses the driving power itself and compels it to force the friction surfaces into contact; and not only so, but should the friction surfaces slip by an increase in the load the power takes hold again automatically and tightens them.

The driving power of this clutch is limited only by the bursting strain of the shell. The explanation of this is as follows: The scroll plate (Fig. 2) in a 20-in. clutch makes 38 revolutions to one revolution of the gears. The gears D in Fig 1 revolve 12 times to expand the friction blocks ¼-in. The rim of the starting plate travels 131.328 times faster than the friction blocks. This accumulation of power accounts for the slight strain on the worm and gears, and relieves them from any possibility of breakage. So there seems to be no limit to the driving power of this clutch, because the slipping starts the tightening and the tightening stops the slipping.

This principle is, so far as I know, entirely novel in the construction of clutches, and is a great step in advance of anything that has been done heretofore. As soon as the friction surfaces are tight enough to carry the load without slipping the winding ceases, and then, if you do not want it to resume, the power can be unhitched and the clutch will slip and so save the breakage of a machine that becomes jammed. This is a very valuable feature for punches and presses which are liable to jam.

Some good points about this clutch are: It is all enclosed and has no levers, arms, joints or toggles, either outside or inside. It is self-centering and self-adjusting, and takes up any wear of the friction surfaces automatically. A difference in the alinement of the shafts will not prevent its operation. It is put together without a bolt or nut, so there is nothing to work loose. It contains only 13 pieces or parts. It can be made with very little machine work, because the sliding wedges and friction blocks can be cast chilled. There is no end thrust on the shaft, nor any moving collars or sliding parts, the driving members being keyed fast on the two shafts. It takes no more room on the shaft than a common coupling, a 16-in. clutch occupying only 13 ins. The 16-in. clutch referred to is on a 3½-in. shaft, driving 125 HP. with such perfect ease that I would not hesitate to load it up to 200 HP. if I could do so, while a 27-in. toggle joint clutch which I took off was so overtaxed that it slipped.

This clutch consists of three members, or parts. First, a hub and shell A, or overhanging flange, described as the body of the clutch, keyed to a pulley or driving shaft. The second member is the driven part B, and consists of a central plate and hub, keyed to the driven shaft, which receives the scroll plate and carries the gears, right and left-hand screws, the wedges mounted on said screws and the friction blocks with converging ways on the inner edges.

The third member consists of two plates, a starting plate C and a scroll H, which revolves independently on the hub B and meshes with the worm gears D. Attached to the starting plate C is the bowl E, loosely mounted on the stud F (Fig. 2). G is the starting spring, which is fastened to the edge of the scroll plate at H (Fig. 3).

The operation of the clutch is as follows: The starting plate C (Fig. 4), which is loose on the hub of the scroll plate, being turned one-fourth of a turn in the driving direction, either by hand or by power, carries forward the bowl E (Fig. 2), on the inclined spring G (Fig. 3) until it makes a contact with the inside rim of the shell or body of clutch, as shown at E (Fig. 3). This contact presses the spring against the inside of the shell sufficiently hard to drive the scroll (Fig. 2) at the same speed as the body of the clutch A. Then the scroll shown in Fig. 2 turns the gears and right and left-hand screws, forcing out the wedges against the inclined ways and pressing the friction blocks against the inside of shell or body of clutch A. This operation continues as long as any relative motion exists between the two parts A and B.

As soon as the speed of the driven part B, which carries the gears and frictions, equals that of the driving part A the winding motion ceases. Should the friction surfaces slip by an increase in the load, the relative motion of the two parts is resumed, and this starts up the winding motion and tightens them. By relative motion is meant a difference in speed between the driving and driven parts.

To release the clutch the plate C (Fig. 4) is retarded either by hand or by a friction shoe worked from the floor. This disengages the bowl E from the shell or rim A. The bowl runs into the pocket, as shown in Fig. 3, where it remains. This stops the scroll plate and causes the worm gears to revolve around the scroll, thus unwinding the screws and releasing the friction surfaces and stopping the driven part.

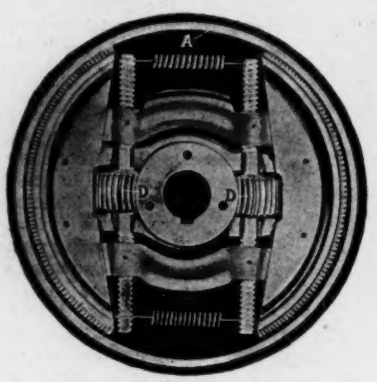

Fig. 1.

Fig. 2.

Fig. 3.

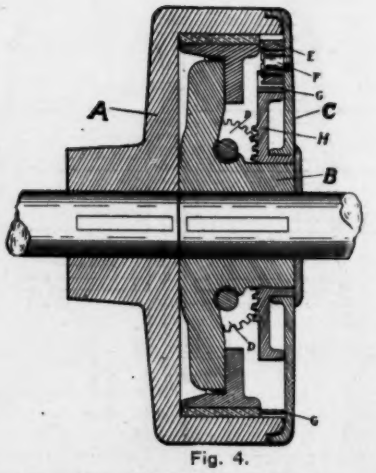

Fig. 4.

FIGS. 1 TO 4. DETAILS OF THE PHILIPS FRICTION CLUTCH.

A UNIVERSAL SAW-BENCH FOR PATTERN SHOPS.

The accompanying illustrations represent a new universal saw-bench or wood-trimming machine, intended especially to meet the requirements of pattern shops and of shops making templets for structural work. It is adapted also for the use of carpenters and cabinetmakers. The machine has an open box frame or base, strengthened by ribs and brackets and having all bosses cast solid on the frame. The hole for the arbor yoke is 6½ ins. diameter, with side bearings 2 ins. wide, all bored and faced. The base covers a floor space 30 × 40 ins., and the height of the machine from the floor is 36 ins. Its weight is 1,800 lbs. Fig. 1 is a general view of the machine, with a core box in position for being hollowed out by the saw; Fig. 2 shows the top tilted for cutting work at an angle, and the sliding portion of the table removed to show the saws; Fig. 3 is a view of the mechanism, the stationary and sliding portion of the table being both removed.

The machine has two saws, mounted on shafts

*Abstracted from a paper read before the New England Cotton Manufacturers' Association.

†Jamestown, N. Y.

or arbors at the opposite ends of a pivoted yoke, Fig. 3, each shaft having a belt pulley. One saw extends through the slot in the table, while the other hangs below in the hollow base, as shown in Fig. 2. The yoke is cast in one piece with the large worm wheel shown in Fig. 3. Beyond the worm wheel the yoke is journaled in the base casting, the part extending outside the base being threaded and held so that it may be revolved by a hand wheel. The required friction

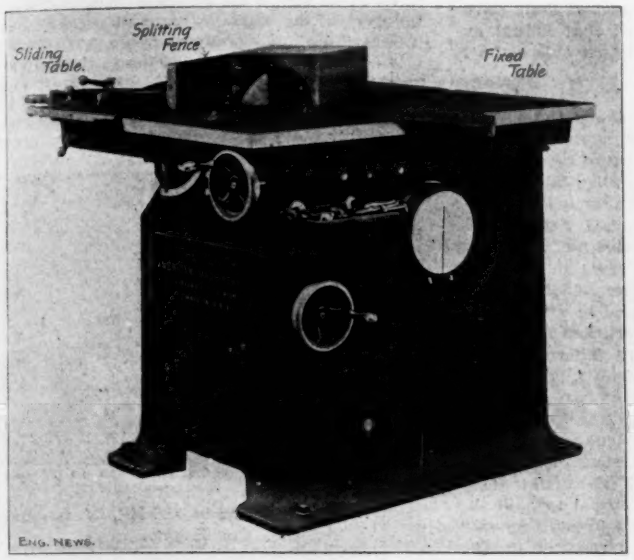

Fig. 1. General View of Complete Machine with Tables in Level Position.

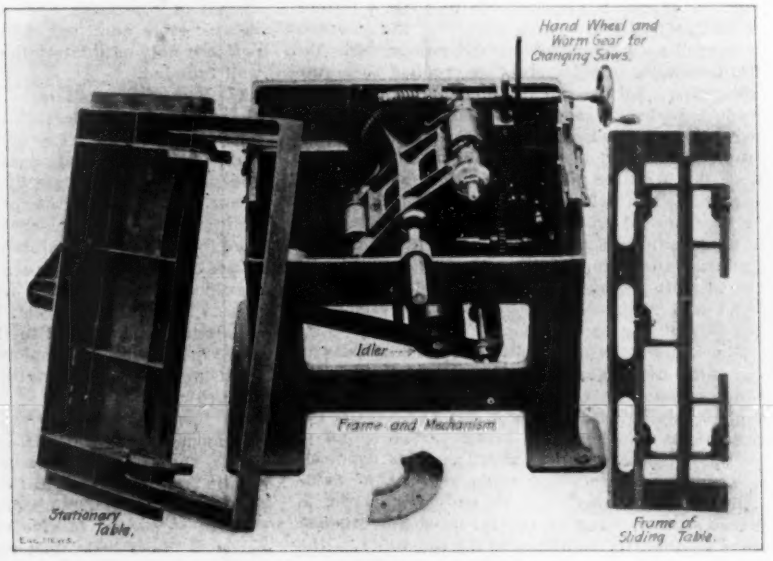

Fig. 3. View with Tables Removed to Show Mechanism.

THE OLIVER UNIVERSAL SAW BENCH FOR PATTERN SHOPS.
American Machinery Co., Grand Rapids, Mich., Makers.

is regulated by the large threaded cap shown in Fig. 1, which draws the parts together and locks them when the desired amount of friction is obtained. The opposite end of the yoke is hollow, as shown in Fig. 3, and has a steady plug, which may be used when saws larger than 14 ins. diameter are used. The yoke may be reversed or shifted to bring either saw into position for work by means of the hand wheel and worm shown at the top of Fig. 3, the worm gearing with the worm wheel cast on the yoke.

The machine is supplied with two 14-in. saws (one cut-off saw and one rip saw), but saws 8 to 20 ins. diameter, with 1-in. holes, may be used. The saw arbors are of crucible steel, 1 3-16-ins. diameter, and one of them is made extra long between the collars to admit dado heads or other forms of cutters. The bearings are long, and are lubricated by capillary attraction from oil wells cast in the yoke. The flanged belt pulleys on the arbors are 4 ins. diameter and 5 ins. wide on the face. When the machine is to be belted from the floor upon which it stands, an idler jack is required. This is enclosed in the base, as shown in Fig. 3, and by its own weight it adjusts the tension on the belt. The idler pulley, 6 × 6 ins., has large bushings, the pulley revolving upon the bushing, or both pulley and bushing revolving upon the shaft. The countershaft, outside the machine, has a 16-in. driving pulley, and two 10-in. fast-and-loose pulleys.

The top or table is 36 × 44 ins., divided into two sections. One of these is stationary, and is 20 ins. wide, with an 8-in. extension to facilitate the use of the guide or fence over the entire width of the table. The other section is a sliding table, 16 ins. wide, moving on roller bearings. By means of a taper plug, the cut-off (or miter gage) or the splitting fence can be located at once on all the prominent angles (for triangle, miter, hexagon, octagon or square) on both acute and obtuse angles from 30° to 135°. The table is graduated near its center for small work, and at the extreme end for larger work. The whole top may be tilted to any angle up to 45° (miter angle) by means of a hand wheel with a worm on the shaft. The handle is shown in Fig. 1 under the tool shelf, while the worm gear can be seen in Fig. 3, at the extreme right hand, inside the base casting. The table is securely held without tightening any bolts or nuts. The dial over the name plate in Fig. 1 shows the angle of inclination of the table. The slot or throat between the two parts of the table can be adjusted from a width just sufficient to clear the saw to a width of 2 ins. The semicircular rockers, by which the top rests on the base, Fig. 3, are 9 ins. diameter, tongued and grooved, and put together iron to iron (without babbit).

The miter cut-off gage will operate up to 36 ins. in width, and can be set to cut at any angle between 30° and 135°. With an extension attached on the other side of the saw, it cuts both right and left hand to miter (45°) and its complement (225°). An auxiliary gage may be attached to the fence, upon which slides a stop for regulating the length when several prices are required. The splitting fence, Figs. 1 and 2, takes work up to 17 ins. wide, and adjusts from square to miter parallel with the saw. It can also be set at any angle not in line with the saw on either the sliding or stationary parts of the top by using one of its two plugs as a center pin. This enables the saw to be used to cut semicircular core boxes of any size, as in Fig. 1. To the face of the fence may also be secured an attachment to facilitate the handling of small

Fig. 2. View with Top Tilted and Sliding Table Removed.

short pieces, and with this in use the work does not have to be pushed clear beyond the saw.

The machine above described is known as the Oliver saw-bench, and is manufactured by the American Machinery Co., of Grand Rapids, Mich. We are indebted to that company for photographs and information respecting the machine.

A PROPOSED ASPHALT-MACADAM PAVEMENT.

By S. Whinery, M. Am. Soc. C. E.*

The good and the bad qualities of sheet-asphalt pavements, and of macadam pavements, are quite well understood by civil engineers, city officials, and the public at large. No perfect pavement for the roadways of streets has been found, nor is it likely that it will ever be discovered.

A good sheet-asphalt pavement undoubtedly comes nearer to the ideal roadway than anything yet devised. Its merits are briefly: A smooth and hard surface offering little resistance to vehicular travel; its comparative noiselessness; its sanitary qualities, the facilities it offers for cleanliness, and the comfort it offers for travelers over the street. Its defects are its high first cost; its slipperiness under certain conditions; its tendency to crack and "scale"; its hardness, on the one hand, making it rather trying to the feet of horses using it, and its plasticity on the other hand, making it liable under certain conditions to "shift" and take the form of alternate ridges and depressions, thus rendering it less comfortable to travel over, and increasing the resistance it offers to vehicle travel.

The merits of a properly constructed macadam pavement are its low first cost; its fair durability when properly cared for; the unexcelled foothold it offers for horses; its comparative elasticity, rendering it an easy pavement for horses to travel over, and the facility with which it may be repaired without skilled labor. Its disadvantages consist in the lack of durability under heavy travel; the dust arising from the pulverization by travel of the smaller fragments of stone used for "filling" and for evening up the surface of broken stone, rendering it necessary to keep it well sprinkled; the comparative high cost of keeping it in repair, and its tendency to "ravel," or disintegrate during very dry weather unless it is well watered.

If a pavement could be found that would combine to a large degree the merits of these two kinds of pavement, and, at the same time, be comparatively free from the defects of each, it should be of great value to the public at large.

It is believed that the pavement described herein will be found to meet these conditions to a very substantial extent. The name proposed for it, asphalt-macadam, conveys an idea of its character.

It may be briefly described as follows: The foundation may be either of broken stone, as in ordinary macadam roads, or it may be of hydraulic cement concrete, such as is generally used with asphalt pavements. The question as to which foundation is advisable will depend on local conditions, such as the character of the earth

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upon which it must rest—called the sub-grade—and the relative cost of each kind of foundation, of such depth as will furnish the requisite support to the wearing surface. The function of the foundation is to support and distribute the concentrated wheel loads, and transmit the pressure to the sub-grade.

The wearing surface consists of a layer of sufficient thickness of the best character of very hard rock, commonly called "road metal," the voids of which are filled and the inequalities of surface of which are levelled up with a bituminous composition very similar to the "surface mixture" used for sheet-asphalt pavements. The hard rock, or "road metal," is crushed to a suitable size. All fragments above and fragments and dust below certain stated dimensions, are carefully screened out of the material as it comes from the crusher. This selected material is spread over the prepared foundation in an even layer of the requisite thickness. Either before or after it is thus spread on the foundation it is heated to a temperature of about 300° F. This is done to facilitate the filling of the voids in the mass with the bituminous composition, and to insure a close bond and firm adhesion between the stone and the bituminous composition.

The bituminous composition is substantially of the same materials and is prepared in much the same manner as the wearing surface of sheet-asphalt pavements, the component parts and the consistency of the mass being varied so as to secure the best practical results. This composition, when prepared, and while still at a sufficiently high temperature to be very plastic, is spread over the top of the layer of hot crushed stone in quantity sufficient to fill the voids in the stone, and to level up the unevenness of its surface, and is properly graded with paving rakes. When this operation is completed a steam roller weighing not less than ten tons, of the "asphalt" type, is operated over the surface until the plastic composition is forced into every void in the mass of stone, the unevenness of the surface filled up, and the whole mass thoroughly compressed and solidified. The roadway is then complete, and after giving it time to become cold and hard the street is opened to travel.

It is not here attempted to describe all the details of the work—they will be evident to those acquainted with the methods of constructing macadam and sheet-asphalt pavements.

No pavement of the kind has yet been actually constructed and submitted to the crucial test of behavior under travel, but it is believed that this new kind of pavement will possess the following merits:

(1) Its first cost will be materially less than sheet-asphalt pavement. The expensive part of sheet-asphalt pavement is the wearing surface, composed entirely of asphalt mixture. In the new pavement the greater part of the wearing surface is crushed stone, a comparatively cheap material. The bituminous composition required to fill up the voids in the stone and level up the surface, will not exceed 50% of the whole mass, and will probably be about 45% of the mass.

(2) The surface of the new pavement, consisting of exposed parts of the crushed stone and the bituminous composition, should be almost, although probably not quite, as smooth and noiseless as the surface of a sheet-asphalt pavement, and should offer but little more resistance to traction than a pavement wholly of asphalt.

(3) The new pavement, while offering a smooth surface, should afford a better foothold for horses because of the surface being partly formed of crushed stone.

(4) The new pavement should be at least as durable, and will probably prove more durable than sheet-asphalt pavement. The fragments of crushed stone will be very firmly held in place by the bituminous composition, and its exposed surfaces will wear off level with the general surface of the street, by the abrasion of travel. At the same time, these stone surfaces will to a great extent protect the surrounding surface of bituminous composition from excessive concentrated pressure, which is the prime cause of the defect called "scaling" in asphalt pavements subjected to the heaviest class of travel under certain well understood conditions. This "scaling" is a principal, if not the principal, cause of disintegration and rapid reduction in thickness of sheet-asphalt pavements.

(5) The new pavement will not "shift" under travel into ridges and hollows as does a sheet-asphalt pavement. The angular fragments of stone of which the mass of the pavement is composed, will effectually prevent such shifting.

(6) It is believed that the new pavement will not crack, which is one of the most common causes of complaint against sheet-asphalt pavement. It is admitted, however, that actual experience only can determine whether this claim is well founded.

(7) The new pavement can be repaired more cheaply and with less skilled labor than sheet-asphalt pavement. The body of the wearing surface, being crushed stone, can be procured cheaply and put in place by unskilled labor. Only about half the quantity of bituminous composition necessary for a sheet-asphalt pavement is used in the new pavement, and this fact will make it practicable to prepare and store in packages a sufficient quantity for ordinary repairs, which can be taken to the street, heated in an ordinary re-heating pan, applied to the crushed stone, and rolled with a heavy hand roller. This facility of repairing should be a matter of no small importance to cities.

(8) The new pavement will be free from one of the most serious objections to macadam pavements, that of dust. The great mass of this dust results from the pulverization of the smaller fragments of stone and "screenings" used to bind the crushed stone and to give the roadway a smooth surface. Very little dust should result from the slow wear of the larger stone fragments in the new pavement, and it should be practically as free from dust as an asphalt pavement.

(9) The disintegration called "raveling," caused by the drying out of the surface of macadam roads during periods of drought will not occur with the new pavement, since the bituminous composition binder will not be affected by the absence of moisture.

(10) Since the bituminous part of the pavement will be made with a greater percentage of bitumen than is used in sheet-asphalt pavement, and will be, in a measure, shielded from the effects of excessive travel by the crushed stone, it should be possible to use a composite asphaltum cement, which, while it may not have as great strength and endurance as the best paving asphalts, will not be affected by water to the same extent as these asphalts.

It is believed that this pavement will be found especially satisfactory for residence streets and business streets of moderate travel, where something better than a macadam pavement is wanted, and the expense of a sheet-asphalt pavement is not justified.

It will be observed that this pavement is entirely different from that known as "tar macadam pavements," in which the broken stone is slightly coated, before or after it is laid on the street, with hot coal tar pitch.

A patent on this method of constructing roadway surfaces has been allowed to the writer.

EFFICIENCY TESTS OF A 125-HP. GAS ENGINE USING NATURAL GAS.

At the meeting of the American Society of Mechanical Engineers in December, 1899, Mr. C. H. Robertson, Instructor in Engineering at Purdue University, read a paper describing some tests made upon a 125-HP. Westinghouse gas engine, installed in the plant of the Merchants' Electric Lighting Association at La Fayette, Ind. Since then other tests have been made, which are reported with great completeness in a second paper by Mr. Robertson, read at the recent meeting of the Mechanical Engineers at Milwaukee.

The engine tested is of the vertical three-cylinder type, using the Otto or four-stroke cycle.

The following extracts from the paper include the matter most worthy of record:

The pistons have a diameter of 13 ins. and a stroke of 14 ins. The gas and air on their way to the engine pass through what is known as the mixing-valve chamber, at the top and bottom of which are two horizontally moving levers, with pointers swinging over graduated arcs. The upper lever, by turning a cylindrical valve within, changes the area of the port for admitting gas. The lower lever, by means of a similar device, changed the area of the air-admission ports. The graduations on the arcs are such as to give the ratio of gas to air which has passed into the interior of the mixing valve. Without in any way affecting the above setting, a flyball governor is so connected to the mixing valves as to give them a motion in the direction of their length. This motion is utilized in varying the area of the ports through which the mixture passes on its way to the cylinders. It is thus seen that the speed of the engine is controlled by throttling the mixture of gas and air without in any way affecting its quality, and that a working impulse is given every two-thirds of a revolution, whether the load is heavy or light.

One of the cylinders of the engine is so arranged that it can be quickly and easily converted into a single-acting, compressed air engine. By its use, momentum enough is

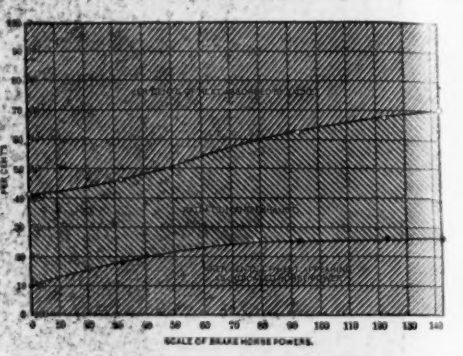

Fig. 1. Heat Balance of 125-HP. Westinghouse Gas Engine.

secured to lightly compress a charge in one of the remaining cylinders, which, on ignition, augments the speed, so that the air cylinder may be thrown into its normal working condition. The air is stored in steel cylinders under a pressure of 160 lbs. per sq. in.

Since the tests reported in the first paper were run, a number of changes have been made in the plant. On account of the uncertainty of the supply of natural gas, one of the gas engines has been replaced by a 150-HP. Westinghouse steam engine, and a boiler plant of Stirling water-tube boilers. The second gas engine was taken out and completely overhauled and remodeled by the builders. This engine, upon being reinstalled, was run for about two weeks, in order that it might be adjusted and gotten into good condition, after which the tests here given were run.

The principal changes in the gas engine were as follows:

(1) Cylinder oil was substituted in the crank case for a mixture of cylinder oil and water, previously used.

(2) Larger openings were provided for the supply of air to the mixing-valve.

(3) External pipe connections were supplied for passing the cooling water from the head to the jacket of the

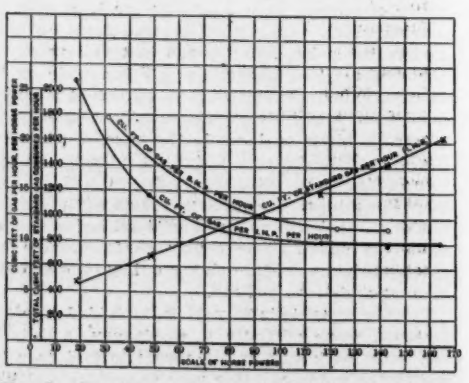

Fig. 2. Gas Consumption of 125-HP. Gas Engine, Showing that Willan's Law is Applicable to Gas Engines.

cylinder, rather than have it pass directly through cored holes, as before.

(4) The cooling water pipes were made larger.

(5) The old cylinders were replaced by new.

(6) Various minor details of mechanism were improved and refitted.

The average indicated horse-power for the test was about 113, the highest being 142 and the lowest 52. Corresponding brake horse-powers were 92, 123 and 31. The frictional horse-power varies from 15 to 31, the average being about 21. The mechanical efficiency is, of course, low at low power. The highest figure, 80%, is certainly good for a gas engine. The gas per indicated horse-power be-

came as low as 9.7 cu. ft. and per brake horse-power 12.29 cu. ft. The averages for the test in regard to these two items are 10.62 and 13.69, respectively.

The thermal efficiency of the engine, in terms of brake horse-power, is of interest, and, at its best, shows that nearly one-quarter of the energy of the gas is realized at the flywheel. At its best performance somewhat more than one-fifth of the heat of the gas was realized in electrical horse-power at the switchboard. The best result obtained was 157 B. T. U. per indicated horse-power hour, a figure which has never been realized in steam engine practice.

A series of short tests were made for the purpose of showing the distribution of heat between the equivalent of the indicated horse-power, the jacket and the exhaust. The results of these tests are shown in Fig. 1. This diagram was constructed by first plotting the percentage of heat equivalent to the indicated horse-power against the brake horse-power of the engine. The per cent. of heat absorbed by the jacket was next plotted downward from the top of the same scale, leaving as a difference

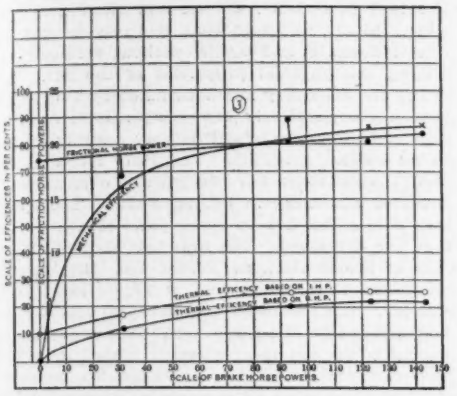
SCALE OF EFFICIENCY IN PER CENTS.
SCALE OF FRICTION HORSE POWERS.
FRICTIONAL HORSE POWER
MECHANICAL EFFICIENCY
THERMAL EFFICIENCY BASED ON I.H.P.
THERMAL EFFICIENCY BASED ON B.H.P.
SCALE OF BRAKE HORSE POWERS.

Fig 3. Efficiency Curves of Gas Engine.

between the two the amount radiated and exhausted. As might be expected, the per cent. appearing as indicated horse-power increases with an increase of horse-power. The per cent. absorbed by the jacket decreases a little more rapidly than that equivalent to the indicated horse-power increases. This results, of course, in a net increase in the amount radiated and exhausted.

At the lowest horse-power of the series (zero brake horse-power) the per cents. in regard to these three factors, equivalent of indicated horse-power, exhaust and jacket, were, approximately, 10, 32 and 58, respectively. At the highest horse-power (143 brake or 164 indicated) the per cents. in regard to these three factors were 26, 44 and 30. The chart illustrates very nicely the well-known fact that a decrease in jacket loss produces an increase in exhaust loss.

In Fig. 2 the straight line shows the gas consumed per hour, plotted against the indicated horse-power. This illustrates, approximately, the Willans law, pointed out in the previous paper. It should be said, however, that a slight curve would fit the points better than does the straight line. The two curves show the relations of gas per horse-power per hour and horse-power. The upper is in terms of brake horse-power, and the lower in terms of indicated horse-power.

Fig. 3 shows the curves for the various efficiencies, and also that for frictional horse-power. The curves for thermal efficiency, based on brake and indicated horse-power, show, as a maximum, 22.56 and 25.8%, respectively.

The points for frictional horse-power show some variation from the line drawn to represent them, but, on the whole, they may be regarded as very satisfactory. In the experience of the author it has been found to be very difficult to secure entirely consistent data for the frictional horse-power of an engine. The curve shows, on the whole, a slight increase of friction with increase of load. The average friction of the five tests in horse-power is 19.9. The equation of this line, in term of brake horse-power, is expressed by th following:

$$F.\ HP. = (F.\ HP.)^{\circ} + C \times B.\ HP.,$$

in which

F. HP. = frictional horse-power;
(F. HP.)° = frictional horse-power at 0 B. HP.;
C = a constant.

By substituting the value of the constants, the equation becomes

$$F.\ HP. = 18.57 + 0.017\ B.\ HP.$$

The fact that the frictional horse-power is practically constant means, of course, that the mechanical efficiency should show an increase with an increase of horse-power. This is very nicely illustrated by the curves for this factor, the data of which were obtained by dividing the brake horse-power by the indicated. The highest value (87%) would be considered a fair one for a steam engine and is certainly very good for a gas engine.

By means of a tuning fork recording device the maximum speed variation with change in load was found to be 1½% below and above normal. Natural gas was used, having a heating value of 970 B. T. U. per cu. ft., as determined by a Junker calorimeter. The temperature of the exhaust varied between 1,408° and 1,800° F. The entering jacket water was at a temperature of about 53° F., and the temperature of the escaping water varied between 80° and 125° F.

DES MOINES RIVER VIADUCT, C. & N. W. RY.

The new cut-off line now being built through Boone, Ia., by the Chicago & Northwestern Ry., in order to obtain better grades and alinement than on the original line, was described in our issue of Feb. 8, 1900, together with the construction of some very large embankments on this cut-off. The most important engineering feature of this work is the viaduct which crosses the valley of the Des Moines River, the total length of the structure being 2,685 ft., and its maximum height 185 ft. from the river to the rail level. It is the longest structure of its kind ever built, being about 500 ft. longer than the Pecos viaduct (Southern Pacific Ry.) but its height is exceeded by other similar structures.

The viaduct consists of steel towers 45 ft. long, with 45-ft. plate girders to each tower and 75-ft. plate girders between the towers. The river, however, is crossed by a truss span of 300 ft. A notable feature of the viaduct is that it is a double-track structure, and it is by far the longest double-track steel viaduct in existence. The tracks are 13 ft. c. to c. This viaduct was opened to traffic on May 19, as noted in our issue of May 23. The weight of metal in the structure is about 5,680 tons, exclusive of cylinder piers, angle iron guard rails, and hand-car refuges.

The Des Moines River viaduct was designed under the direction of Mr. E. C. Carter, M. Am. Soc. C. E., Chief Engineer of the Chicago & Northwestern Ry., and its erection has been under the supervision of Mr. W. C. Armstrong, Resident Engineer, who is in charge of the construction of the new line. The contract was let to the Union Bridge Works, before that firm was absorbed by the American Bridge Co., and the iron work has been built at the Chicago shops of the latter company. Mr. T. W. Cartledge was superintendent in charge of the erection for the American Bridge Co.

A comparison of this viaduct with some other similar structures is given in the accompanying table. The history of the steel viaduct system of construction was given by Mr. J. E. Greiner in a paper on "The American Railway Viaduct: Its Origin and Evolution," written in 1891 for the American Society of Civil Engineers (Eng. News, June 6, 1891), and a list of high viaducts of wood, stone and steel was given in our issue of March 12, 1892. The Gokteik viaduct, in Burmah, recently built by the Pennsylvania Steel Co., is 335 ft. above the ground (not 320 ft. as recently stated in our columns) and is 835 ft. above the water, which here runs through a natural tunnel. This last named structure is designed to carry two tracks, but is constructed at present with only one floor system and track.

AMERICAN LOCOMOTIVES AND BRIDGES IN INDIA AND BURMAH.

An attack upon the Indian government for its award of contracts to Americans was recently made in the House of Commons by Sir Alfred Hickman, ex-President of the British Iron Trade Association. It was alleged that American locomotives in India were proving extravagant in fuel, and the workmanship on the famous Gokteik viaduct was challenged, it being alleged that the riveting was done by unskilled labor and was very defective. The Secretary of State for India, Lord George Hamilton, was not present in the House of Commons when the attack was made; but he later replied to the critic in a published letter, which is quoted at length in cable dispatches, from which we take the following:

No practical engineer who has visited American workshops and inspected their methods of production and manufacture would for a moment indorse your assumptions. Their competition is dangerous because they are yearly improving their products, both in quality and price. It always has been the practice of the Boards of Management of the Indian railroads to give preference in all their contracts to British manufacturers, and that policy has so prevailed that up to the great recent engineering strike no order for a railway locomotive was ever given outside of Great Britain. Since then, owing to the British workshops being blocked with work, certain of the Indian Railway Boards found it necessary, as locomotives could not be obtained here, to place a few limited orders in America.

I am ready to give all the available reports concerning working, consumption of fuel, and load-drawing power of these locomotives. The earlier reports were unfavorable, but, when their working was better understood, and alterations were made to suit the local fuel, a marked improvement was noticed, so much so that one company wishes to obtain more engines of similar construction. That American locomotives obtained a footing in India was due to the strike I have referred to. But if, as I hope, British locomotives are in the future to regain their monopoly in that vast system of railways, British engineers must profit by the hints and suggestions these reports convey.

Concerning the Gokteik viaduct in Burmah, Lord George says the order was placed with a Pennsylvania company because no British firm had anything like the same experience in this class of construction. The Americans bid a less price and quicker time than any other competitor. The charge made by the supervisor of the construction of the viaduct, that the riveting was defective, was in no way supported by a searching inspection. "The Burmah Railway Board," adds Lord George, "composed of the most competent railways experts, are satisfied that the bridge is sound and reliable."

Lord George also says that if he seems to combat Sir Alfred's contention, it is not because he does not heartily appreciate his object. They both wish to assist in maintaining the supremacy of British engineers and workshops against foreign contractors.

"You seem to think," the Secretary continues, "that orders have only gone abroad because those who gave them did not understand their business. I wish it were so. The competition we have to face is founded on something much more formidable and more substantial. Chemical research, the concentration of capital, thorough technical education, and improved industrial organization have made in recent years a greater advance in America than here. It is with the product of these combinations and not with the assumed stupidity of the Indian officials that the British engineer has to contend. So far as I am concerned, I can undertake that preference, unless the difference in price, quality, and delivery is very substantial, will always be given to British firms. May I not ask you, as a leading member of the great steel industry of this country, to co-operate with me by impressing on your associates the necessity of meeting competition in the future, so as to insure that price and time of delivery will be on the side of British production?"

THE WELDING OF ALUMINUM by the Cowper-Coles process was lately brought to the attention of the Royal Institute, in London, but without detailing the process other than to say that it is not electric in its nature and no solder of any kind is used. Specimens of aluminum thus welded were shown and tests of rods welded and unwelded were exhibited. It was stated that cast-aluminum thus welded was tougher and stronger at the weld than at other parts, and the test specimens shown did not break at the weld. The apparatus used is stated to be simple and applicable to any section. The strength of the weld is as great as wrought-aluminum, and is stronger in cast-aluminum, and a perfect weld is made without hammering.

Principal Dimensions of Notable High Railway Viaducts.

Viaduct	Gokteik.	Pecos River.	Kinzua (old).	Kinzua (new)	Panther Cr'k.	Lon.	Verrugas(old)	Ver'gas (new)
Country	Burmah.	United States.	United States.	United States.	United States.	Bolivia.	Peru.	Peru.
Railway	BurmahState.	So. Pacific.	Erie.	Erie.	Wil., B. & E.	Antofagasta.	Lima & Oroya.	
Gage	3 ft. 3⅜ ins.	4 ft. 8½ ins.	4 ft. 8½ ins.	4 ft. 8½ ins.	4 ft. 8½ ins.	2 ft. 6 ins.	4 ft. 8½ ins.	4 ft. 8½ ins.
Number of tracks	One.	One.	One.	One.	One.	One.	One.	One.
Length	2,260 ft.	2,180 ft.	2,023 ft.	2,053 ft.	1,650 ft.	800 ft.	575 ft.	575 ft.
Height, maximum	335 "	321 "	301 "	301 "	161 "	336½ ft.	252 "	252 "
Width between girders	11 "	10 "	10 "	9 "	7 "	8 ft. 10 ins.	.....	.....
Width of floor	.....	20 "	18 "	18 "	.....	13 ft.	.....	.....
Width at base, maximum	156 ft.	90 ft. 3 ins.	.....	102 ft. 8¼ ins.	.....	124 ft.	.....	58 ft. 4 ins.
Weight of metal	4,310 tons.	1,820 tons.	1,400 tons.	3,352 tons.	830 tons.	1,115 tons.	.....	.....
Tower spans	(16) 40 ft.	35 ft.	38½ ft.	38½ ft.	30 ft.	32 ft.	50 ft.	60 ft.
Intermediate spans	{(7) 60 ft., (10) 120ft.}	65 "	61 "	61 "	40, 60 & 65 ft.	80 "	100 & 125 ft.	235 ft. center, 140 ft. shore.
Maximum span	120 ft.	185 ft.	61 "	61 "	65 ft.	80 "	125 ft.	235 ft.
Date of construction	1900.	1891-92.	1882.	1900.	1893.	1888.	1872.	1890.
Published in Engineering News	Feb. 28, 1901.	Feb. 6, 1892, Jan. 5, 1893.	July 5 and Sept. 20, 1890.	.....	Feb. 22, 1894	May 18, 1889; July 5, 1890.	July 27, 1889.	May 9, 1891.

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ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The announcement of a new storage battery, invented by Mr. T. A. Edison, which we briefly noted last week, has been seized upon by the newspapers and all sorts of extravagant prophecies are being made concerning the results which will follow the new invention. The New York "Evening Post," for example, thinks that with the new storage battery the electric automobile will displace the truck and the dray, the delivery wagon and the physician's carriage, electricity will take the place of steam for tugboats, ferry-boats, etc., and "electric torpedo-boats will make a coast guard that will daunt the most formidable invader."

Without expressing any opinion as to the scientific importance of Mr. Edison's invention, it appears to us that conclusions as to its commercial importance are at present premature. According to Mr. Kennelly's account of the new battery, the active material in the negative plate is an oxide of nickel. Now, nickel is a metal which is neither low in price or available in unlimited amounts for commercial use. As we pointed out a year ago, in discussing the uses of nickel steel, the world's total production of nickel is far too small to permit the general use of nickel steel as a substitute for ordinary steel. If the total present annual world's production of nickel were used in steel manufacture, it would only produce about a quarter-million tons of nickel steel. The present price of nickel is 50 to 60 cts. per lb., which restricts the use of nickel for the treatment of steel to high-class work, such as ship and engine forgings, artillery material, naval work, etc. Future development of the nickel deposits of Canada and New Caledonia, and future improvements in methods of reducing the metal from its ores, may, indeed, increase the output of the metal; but are very unlikely to cause any great reduction in its price. Any such price reduction would at once stimulate the use of nickel in steel manufacture and cause it to be applied in many fields where the present price is prohibitory.

The bearing of these facts upon the commercial value of Mr. Edison's invention is obvious. A storage battery made of material costing 50 to 60 cts. per lb. may have all the advantages claimed for the new Edison battery, and yet have a very limited field of commercial use. For automobile races, which have become so popular among the fast set, the new Edison battery may "fill a long-felt want," and amply reward its inventor; and there are doubtless other similar fields where it may find a limited use. Because it may win fame in such applications, however, it does not follow that it can find any foothold where the question of dollars and cents controls. The "Evening Post" thinks "the cart-horse will disappear from our streets, because no one can afford to use so expensive a means for moving merchandise." So far as at present appears, however, we are inclined to think the cart-horse will hold his job for some time to some.

The long-standing question as to who is and who is not entitled to call himself an engineer, is to come up for discussion at the approaching annual convention of the American Society of Civil Engineers. Among the topical questions propounded for discussion at the session on June 26 is the following:

> Do the interests of the profession, and the duty of its members to the public require that only those who are competent be allowed to practice as civil engineers? Under what authority, through what agency, and upon what evidence of competency, should applicants be admitted to the practice of civil engineering?

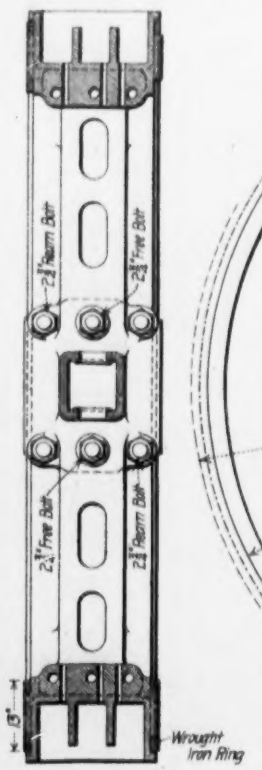
Time was, and not so very long ago, if memory rightly serves, when a member who offered a resolution upon this subject at a meeting of this Society was promptly sat upon by the powers that be. That a more liberal spirit now prevails is evidenced, we trust, by the appearance of this question in the official program. The discussion will doubtless cause no changes in the existing status; but it may effect something in the way of clarifying men's minds and inducing those who hold opposing views to look at the matter from each other's standpoints. A frank and full discussion will clear the air, promote a better understanding and perhaps greater contentment with existing conditions.

The recovery of steel from overstrain and the effect of time and temperature on this phenomenon has been made the subject of some interesting tests at the McGill University laboratories at Montreal, Canada. In a paper read before the Canadian Society of Engineers, recently, Prof. Ernest G. Coker describes the methods and results of these tests in considerable detail. Briefly stated, the proposition started with was as follows: When iron or steel is subjected to tensional stress sufficient to cause a permanent stretch in the material the ductility is reduced and ultimately the elastic limit rises. As a first consequence, however, the elastic limit is first of all lowered, in some cases to zero, but if the bar be left to itself the elastic limit ultimately rises to a higher value than before. The tests noted above were made to determine the correctness of this proposition and also to determine what effect temperature as well as time would have on the perfectness of the recovery. The first tests made were tension tests on a mild steel bar cut from boiler plate; there were several of these tests made, but only one is selected for illustration. This bar had a breadth of 2.07 ins., a thickness of 0.377 ins., and a length of 8 ins. The load was applied to the bar by increments of 2,000 lbs. At 23,000 lbs. permanent stretch began, which increased until at 27,000 lbs. the original 8-in. bar was 8.165 ins. long, as measured by the Ewing extensiometer. Upon removal of the load the bar returned to a length of 8.15 ins. The measuring instrument was immediately reset to the standard distance of 8 ins. and a retest made with the load rising by increments of 2,000 lbs. to 24,000 lbs. and then falling by decrements of 2,000 lbs. to zero. The readings obtained in this test showed no linear relation between the stress and the stretch, but that the latter rose irregularly as the stress increased. The differences of the readings as the load increased were irregular and did not agree except accidentally with the differences obtained as the load was removed. The bar was now laid on one side and a gradual recovery of its elastic properties took place. At the end of three hours there was a marked recovery; the tests of the bar were repeated at the end of one day, three days, seven days and 28 days and these showed a further recovery whose rate diminished with time, but at the end of the month the recovery was practically complete. Tests were made with shearing strains and showed practically similar results.

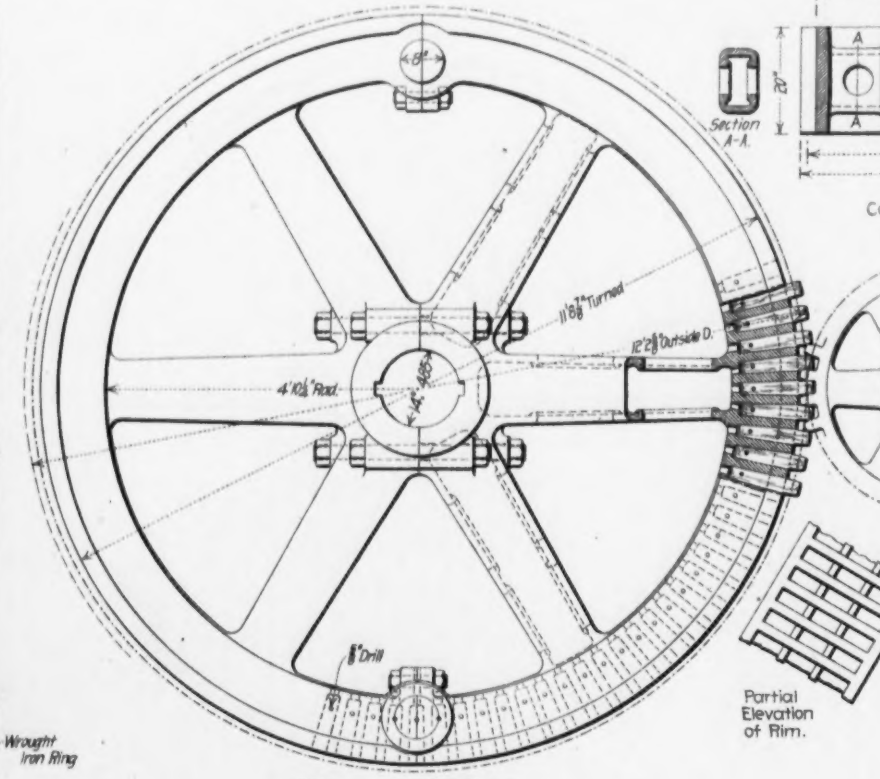
The effect of time on the recovery of steel subjected to overstrain being established in so remarkable a manner, attention was turned to the effect of temperature. It is well known that if a bar of iron or steel be strained beyond the elastic limit in tension, it will regain its elastic properties if raised to a dull red heat and allowed to cool slowly in air, and also that this process may be repeated again and again without seriously effecting the physical properties of the bar. Recently the discovery has been made by Prof. Muir that a comparatively low temperature, such as that of boiling water, will restore a stretched bar to its elastic condition. The tests made at the McGill laboratories were designed to determine the effect of annealing in boiling water. The specimen was a flat bar of boiler plate similar to the first one described. The first test showed distortion at 20,000 lbs.; at 25,000 lbs. the stretch amounted to 8.13 ins., and at 27,000 lbs. it was 8.15 ins. The load was then removed and the bar was exposed for ten minutes to the temperature of boiling water and then retested. This second test gave the yield point at about 31,000 lbs., and further tests preceded by annealing in boiling water gave yield points at 36,500 lbs., 41,500 lbs., 45,600 lbs., and finally 48,100 lbs., when the bar broke, with a total extension of about 15 per cent., or about 6 per cent. less than would have been obtained if the bar had been strained to rupture without any intermediate treatment. Prof. Coker states that even a temperature of 50° C, effects a considerable physical change in a bar of overstrained material, restoring its elasticity and raising the yield point. Shearing tests showed practically similar results. The beneficial effect of annealing even at very low temperatures being established, tests were undertaken to discover if the converse of this was true; that is, whether low temperatures would have the contrary effect of retarding recovery from overstrain. The details of the test will not be given, but the general conclusion arrived at from them was that: Low temperatures tend to retard in quite a marked degree the recovery of steel when subjected to overstrain. The practical value of these results to the engineer lies in the forcible manner in which they impress the fact that the working efficiency of steel may be materially affected by ordinary small changes in temperature.

The single-rail railway delusion, which at one time infected a good many otherwise sensible people in this country, has broken out in a virulent form in England, where a Mr. Behr is proposing to build a single-rail line between Manchester and Liverpool, over which he promises to carry passengers at the rate of 110 miles per hour. A bill to authorize the construction of the road is now before Parliament, and the reports of the committee hearings upon it remind one of the days when Captain Meigs' saddle-back railroad, and in later years E. Moody Boynton's bicycle railroad, were urged as the only possible means by which rapid transit could be given to Boston.

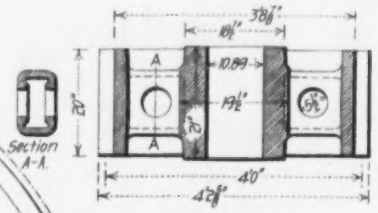
As many of our readers will remember, both the Meigs scheme and the Boynton scheme were very strongly supported before the Massachusetts legislature, and came very near obtaining the desired franchises. For the Liverpool and Manchester scheme, now before Parliament, the promoter has succeeded in securing quite an array of expert talent to testify as to the soundness and feasibility of his plans. On the other hand, it is opposed by such experts as Sir Douglas Fox, late President of the Institution of Civil Engineers, and Mr. C. A. Carus-Wilson, late Professor of Electrical Engineering at McGill University.



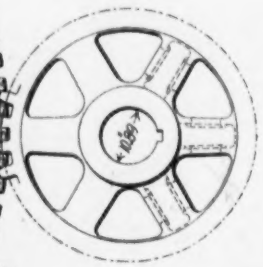
Vertical Section of Spoke and Rim.

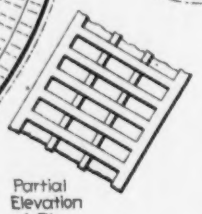


Side Elevation.

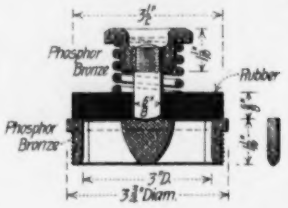


Cast Iron. Pinion.

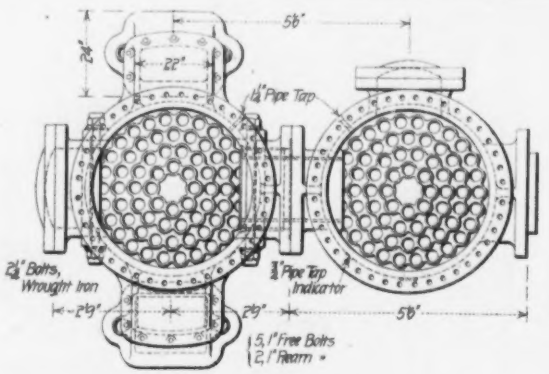




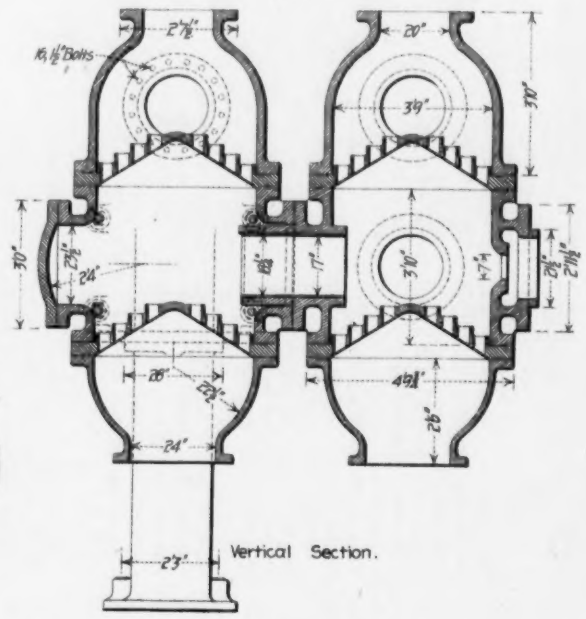
Partial Elevation of Rim.



DETAILS OF VALVE.



Plan.

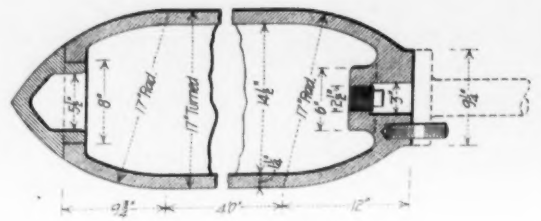


Vertical Section.

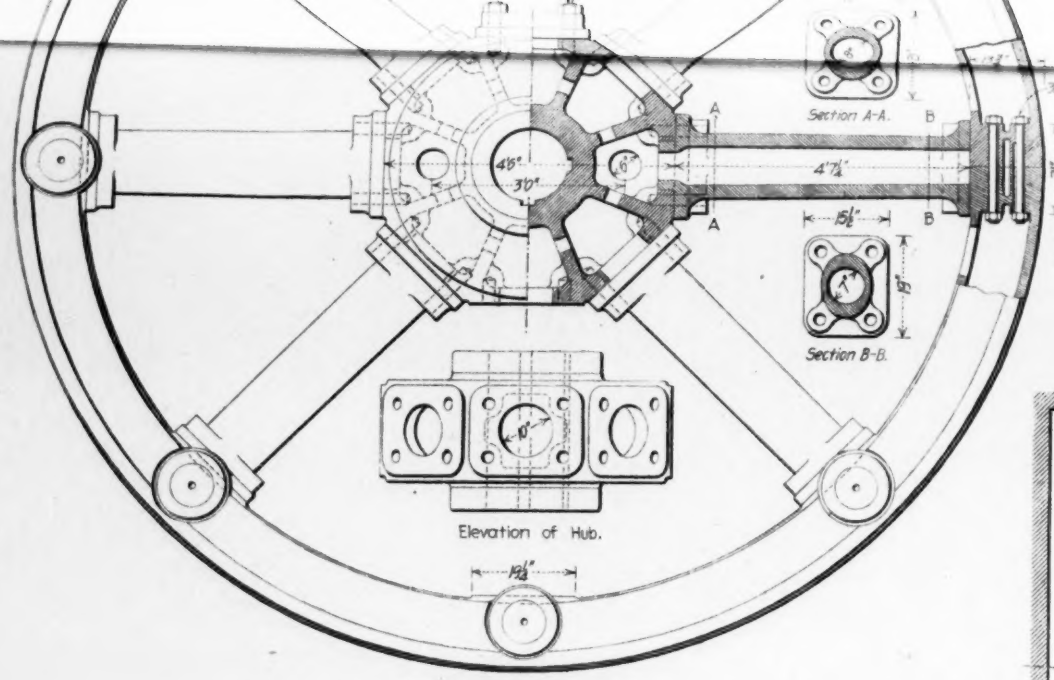
PLAN AND SECTION OF VALVE CHAMBERS.

Horizontal Section.

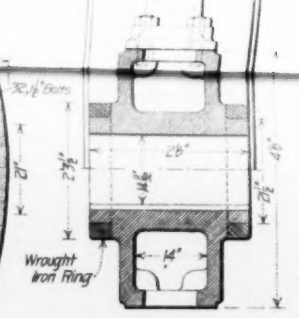
DETAILS OF GEAR WHEEL AND PINION.



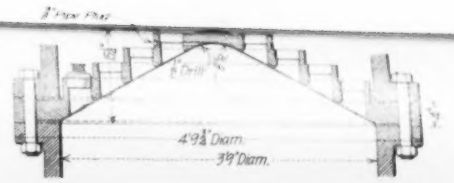
DETAILS OF FLANGES.



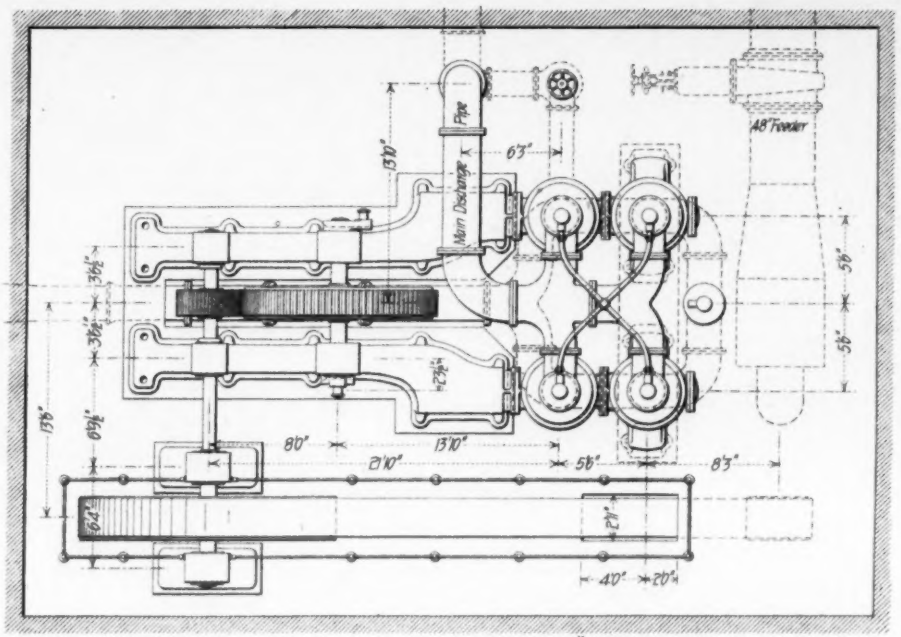
DETAILS OF FLY-WHEEL.



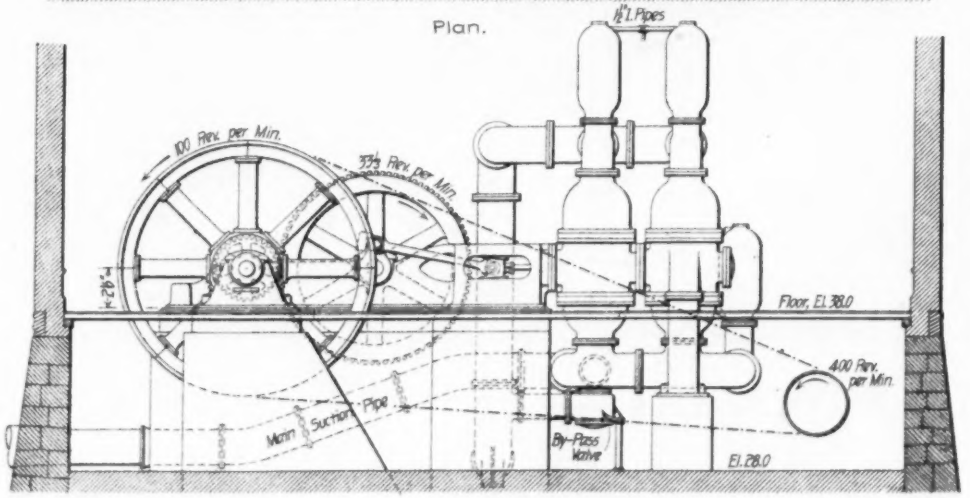
Part
Vertical Section.



SECTION OF VALVE SEATING.



Plan.



Elevation.

ELEVATION AND PLAN OF PUMP AND TRANSMISSION MACHINERY.

WATER POWER

PUMPING MACHINERY

FOR

PENNICHUCK WATER-WORKS,

NASHUA, N. H.

Dean & Main,

Boston, Mass.,

Engineers.

CHAS. HART, LITH., 86 VESEY ST., N. Y.

BOOK REVIEWS.

PRINCIPLES AND PRACTICE OF ARTIFICIAL ICE-MAKING AND REFRIGERATION.—By Louis Schmidt, Ph.B. Philadelphia: Philadelphia Book Co. London: Sampson Low, Marston & Co. Cloth; 6 x 9 ins.; pp. 224; 87 illustrations. $2.50.

This book opens with a discussion of ice-making and refrigeration, including the history of the two divisions of the subject, the principles involved and the general methods employed for the production of low temperatures. The author next describes the systems and apparatus of various patentees and manufacturers. He then devotes a chapter to structural insulation, such as cold storage compartments and buildings. In conclusion, a variety of useful information and tables are given. There are a number of sectional diagrams showing the arrangement of plants of different types and makes, besides reproductions of detail drawings and of photographic views. The book promises to be handy and useful to those engaged in the rapidly-growing industries which it discusses and to anyone who wishes to post himself generally on the principles and practice of ice-making and refrigeration.

THE NORTH RIVER TUNNEL may be commenced again under a reported agreement between the American investors and the English stock and bondholders.

THE MASSACHUSETTS TOPOGRAPHICAL SURVEY Commission may be abolished under a bill now before the Massachusetts Legislature proposing to transfer all its powers and duties to the Board of Harbor and Land Commissioners. The Topographical Commission was established in 1884, and in co-operation with the U. S. Geological Survey it has done a large amount of excellent work in connection with the State and town boundary lines and the preparation of town atlases. The present members are Mr. Desmond FitzGerald, Past President Am. Soc. C. E.; Mr. Frank W. Hodgdon, M. Am. Soc. C. E.; Prof. Alfred E. Burton, and Henry B. Wood, M. Am. Soc. C. E., is the Chief Engineer of the Commission. This commission serves without pay. The Board of Harbor and Land Commissioners includes Mr. Woodward Emery, Mr. Clinton White, Capt. Charles C. Doten and Mr. Frank W. Hodgdon, M. Am. Soc. C. E., the latter being Chief Engineer. The bill was introduced as a measure of economy, but as the work is to be continued under the new control, and as the Topographical Commission received no compensation, the economy is not apparent. It is possible, however, that there may be some gain in combining the survey and records of the land and water boundaries of the towns, near the coast line at least.

A NOVEL REGENERATOR system has been applied to a boiler furnace at the Olympia Cotton Mills, at Columbia, S. C. The chimney is replaced by a short steel-plate stack extending barely above the roof. An outer shell surrounds the stack, and through the annular space between air is drawn down into the fan room and finally to the fires through ducts extending beneath the ashpits. Draft is produced by two 14-ft. fans driven by direct-connected engines. The entire mechanical draft plant was designed and built by the B. F. Sturtevant Co., of Boston, Mass.

THE LAKE BORGNE CANAL, connecting the Mississippi River with Lake Borgne, back of New Orleans, is to be opened to traffic on June 10. This canal is 7½ miles long, and will open up the whole coast line between New Orleans and Mobile, especially for the lumber trade of Pearl River, Gulfport and Pascagoula.

A COAL CONVEYOR with a capacity of 500 tons per hour has recently been installed at the works of Jones & Laughlins, Ltd., at Pittsburg, to carry coal from the boats on the river front to a large coke oven plant, consuming 2,500 to 3,000 tons of coal daily. The coal is taken from the boats by an elevator consisting of a double row of steel buckets about 4 ft. long by 2 ft. wide and 2 ft. deep. These buckets, 70 in number, are attached to an endless steel chain. The elevator is supported at its head and foot on a boom which is moved in an inclined plane by an electric motor and in this way its position can be adjusted to any stage of water. Another motor drives the chain and a third warps the coal barges into position and moves them along under the elevator as fast as the coal is removed. Through these three motors one man operates the entire system, controlling the working of the elevator and shifting the boats with perfect ease. This elevator was designed by Jones & Laughlins, Ltd., and built at their works. At the head end of the elevator the coal is delivered to a 30-in. Robins belt conveyor furnished by the Robins Conveying Belt Co., of New York city. This conveyor first runs at a somewhat steep incline, the grade being 20°. After reaching a sufficient height the conveyor runs horizontally, crossing several railway tracks, including the main line of the Baltimore & Ohio R. R., over which it passes at a height of 24 ft. Near its inshore end it takes an upward curve and on reaching a height of 68 ft. delivers its load to another similar conveyor running nearly at a right angle to the first. This conveyor is 250 ft. between centers. The second conveyor delivers the coal into three hoppers, distributing it equally between them and automatically ceasing to deliver into a hopper as soon as it is filled. Both conveyors are driven at the end where they receive the load, as by this arrangement the motor of the long conveyor is located in the house which also contains the elevator motors, thus concentrating the power plant under one man's supervision.

THE NEWFOUNDLAND-REID RAILWAY DISPUTE is said to be settled. Robert G. Reid entered into a contract with the Newfoundland Government on Feb. 19, 1898, to operate the Newfoundland railway system of 650 miles for 50 years. He was to pay his own expenses and to pay $1,000,000 cash, and he was to receive a subsidy of 2,500 acres of land per mile. At the end of 50 years, by paying $6,000,000 more, the railway was to become the property of Mr. Reid. He also agreed to purchase the St. Johns dock and the government telegraph system for $500,000; to improve this dock, cheapen the telegraph rates, build eight coasting steamers, and develop the coal on lands included in his subsidy, mine not less than 50,000 tons per year and pay 10 cts. a ton royalty. The contract was approved by the Newfoundland Legislature, but the electors did not approve, and there has been widespread popular opposition since. The details of the new arrangements are not yet made public.

AN INSTRUMENT FOR LOCATING SOUND, called the topophone, has been invented by Lieut.-Col. D. P. Heap, Engineer of the Third Light-House District, Tompkinsville, N. Y., and is described in a recent number of the "Marine Review." The instrument consists of two trumpets pointing in opposite directions and supported on a vertical shaft. From the lower ends of the trumpets rubber tubes extend to specially constructed ear pieces. The observer holds the shaft so that the instrument is above his head. If a sound is heard in either ear, the source of sound must be somewhere on the side from which it is heard. If the observer than turns in that direction until the sound is heard in the other ear, he knows that he has passed the direction of the sound. If he then oscillates the trumpet so that the sound is heard alternately in each ear, the sound will be in a direction inside the angle of oscillation. As soon as the direction of the sound is ascertained, the observer can keep the topophone pointed that way, and, knowing the speed of the vessel and its course, the location of the sound can be quickly plotted.

A "CAST-STONE" CONCRETE CONSTRUCTION for buildings, factories, etc., is being introduced, and its first application on a large scale is at the new works of the Great Northern Portland Cement Co., at Baldwin, Mich., the buildings for which will cover 17 acres. The walls have inside and outside sheathing of "cast-stone" blocks, with interlocking joints, and so formed as to be solidly united with the monolithic concrete mass deposited to form the core of the wall. The blocks are hollow, are a close imitation of stone, and can be made damp-proof and frost-proof. This system of construction has been patented by Mr. C. W. Stevens, of West Harvey, Ill., and 100 Washington St., Chicago. His "cast-stone" construction is already in extensive use for cornices and other architectural features on residences, flat buildings, etc.

THE WESTINGHOUSE AIR BRAKE CO. has acquired control of the Standard Air Brake Co., and the plant of the latter company is to be removed to Wilmerding, Pa., says the New York "Commercial." The capital stock of the Standard Co. is $485,000 preferred and $100,000 common stock. They manufacture brakes for street and suburban railways, operating the air pumps from the car axle. This brake is said to be an improvement over existing types, but it has not been generally adopted. The Westinghouse Co. is to perfect it and to introduce it as rapidly as possible.

CANADIAN RAILWAY SUBSIDIES, says U. S. Commercial Agent Beutelspacher, of Moncton, N. B., aggregate $88,884,557 and 39,725,130 acres of land. Of these amounts the Canadian Pacific Railway received 25,000,000 acres of land and $62,742,816. In addition to these sums the various provinces have granted $31,310,170, and the municipalities $15,884,542, making a grand total of $136,079,269 of public money paid to Canadian railways owned by private concerns.

THE CRAMP-VICKERS-BETHLEHEM COMBINATION, says the Philadelphia "Press," is an accomplished fact. The prices named in the transaction are $15,000,000 cash for the two Bethlehem concerns and $5,000,000 for the Cramp stock. The stockholders of the latter company are to have the option of taking cash or exchanging, share for share, for a 7% preferred stock of the new company. Enough stock is to be sold to provide $5,000,000 working capital.

THE EXPORT OF MINERAL OILS for the fiscal year 1901 will probably be the largest in the history of this industry, says the U. S. Bureau of Statistics. In the period 1876-1900 the total value of mineral oils exported has been about $1,200,000,000; an average of $48,000,000 per year, and commencing with $20,891,000 in 1875 the value of the oil exported in 1900 was $75,612,000. While the export has thus increased so largely, the price per gallon has as steadily fallen from 14.1 cts. in 1875 and 21.1 cts. in 1877 to 4.2 cts. in 1894 and 7.8 cts. in 1900. The average price of the oil exported in the nine months of the present fiscal year is 6.6 cts. per gallon.

THE ANDREW CARNEGIE RESEARCH SCHOLARship of £100 has been awarded by the Council of the Iron and Steel Institute of England to the following three gentlemen: Alfred Stanfield, D. Sc., Assoc. R. S. M., born in England March 18, 1871. From 1891 to 1898 he made a number of researches for the Alloys Committee of the Institute of Mechanical Engineers, and is the author of papers on the solution theory of carburized iron, on thermo-electric pyrometry and on alloys. John Alexander Matthews, Ph. D., M. A., B. Sc. F. C. S., of Brooklyn, N. Y., born May 20, 1872. He is a graduate of the Columbia School of Mines and has presented a number of papers to the American Chemical Society and School of Mines Quarterly. Julius Goldberg, of Loeben, Austria, born April 15, 1876. He was educated at the University of Warsaw and Loeben School of Mines, and is a practical metallurgist.

A NEW FORM OF COMPASS CARD has been worked out by Lieut. Comdr. S. W. B. Diehl, of the compass office of the United States Navy. The circumference of the card is divided into the usual 360° and marked continuously to the right from 0° at North to 90° at East, 180° at South, 270° at West and 360° at North. The card is subdivided as follows: (a) Into divisions of 10°, accentuated by heavy lines on the graduated rim, and by suitable geometric figures on the card, each 10° division of the card being indicated in figures by its appropriate number from 0°, or North. (b) Each 10° division of the card is further subdivided into half and quarter divisions and appropriately marked. (c) Every fifth-degree line of the graduated circle between the 10° division is marked in figures, indicating its appropriate number from 0°, or North. (d) The cardinal and intercardinal directions are emphasized on the card in geometric figures. The object of the proposed change is to omit the present system of points and fractions thereof and use degrees only.

MAGNALIUM is a recent alloy of aluminum, containing between 10 and 25 parts of magnesium to 100 parts aluminum. The German technical press says that with 10 parts of magnesium the alloy has the mechanical properties of rolled zinc; with 15 parts it resembles cast brass; and with 20 to 25 parts it approaches hard drawn brass or red bronze. The addition of 10 to 15% of antimony to the magnalium raises the melting point from 700° C. to a white heat. Less than 10% of magnesium with aluminum causes the alloy to roll well and makes it suitable for making sheets or tubes; the larger quantities of magnesium are more suitable for casting purposes. Herr Kaempfer says the alloy turns well, and is readily drilled and milled and does not slip or bind. Under the file it works like soft brass, but it does not clog the finest cut file. It takes a high silver-white permanent polish; but can be easily blackened. It is harder than pure aluminum and can not be cut with a knife, and has a fine-grained fracture, something like steel. Its specific gravity is 2.52 ± 0.03; its tensile strength ranges between 20 and 24 kilos. per sq. mm.—about 28,446 to 34,136 lbs. per sq. in.; as compared with 15,680 lbs. per sq. in. for cast aluminum and 22,400 to 31,360 lbs. for sheets or bars. The present cost of magnalium is high, as magnesium costs 18 marks per kilo. in Germany, or nearly $2 per lb.

NOTES FROM THE ENGINEERING SCHOOLS.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The corporation has decided to borrow $275,000 with which to erect a building for the Department of Electrical Engineering. It is also announced that the erection of the Walker Memorial Gymnasium is practically assured, as $90,000 of the $100,000 to be raised has been secured.

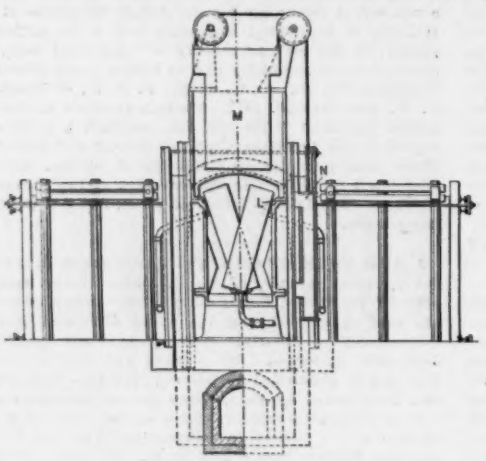
ROSE POLYTECHNIC INSTITUTE.—At the Commencement exercises to be held on June 20, the Commencement Address will be given by Mr. George B. Leighton, President of the Los Angeles Terminal Ry., and the Alumni Address by Mr. Walter B. Wiley, of the Illinois Steel Co.

UNIVERSITY OF MICHIGAN.—In the Department of Higher Commercial Education, courses have been established treating of the origin and development of the legal principles and social customs from which modern industrial organization has sprung, with special reference to land tenure, development of agriculture, development of the factory system, development of commerce, development of business and corporate organization,

development of labor organization and other similar topics. There are also courses given on the history of industrial chemistry, the history of the application of physics to industry, and the history of mechanical and civil engineering.

Professor Geo. W. Patterson, formerly Junior Professor of Physics, has been made Junior Professor of Electrical Engineering.

COOPER UNION INSTITUTE.—A collection of textile fabrics, including the Bodia collection of Barcelona, the Rivas collection of Madrid, and the Baron collection of Paris, has been presented



Charging End.
Sectional Elevation.

to this institution by Mr. J. Pierpont Morgan. These collections include examples of textile fabrics and designs from the Middle Ages to the present time, and are said to be three of the most valuable collections in Europe.

AN IMPROVED TYPE OF INGOT-HEATING FURNACE.*

By F. H. Daniels, M. Am. Soc. M. E.†

In the process of reducing steel ingots to a form suitable for further use in the manufacture of wire, etc., no operation is of greater importance than that of bringing the ingot to a proper heat for rolling. For this purpose a number of forms of heating apparatus have been devised. The earliest, and one which, on account of its many excellent features, still remains in considerable favor, was known as the "soaking pit."

The soaking pit, as generally used, consists, as the name implies, of a chamber into which the ingots are charged vertically from the top, and from which they are later removed in the same manner. This form of furnace is also supplied with regenerative chambers and their concomitant accessories. The introduction of the regenerative principle involves not only a large first cost, including a number of expensive flues, but, on account of the somewhat complicated system of valves, etc., the expense of maintenance is very considerable.

As previously noted, in an arrangement of this sort, the ingots are charged and discharged from the top, the operation necessitating the removal of the cover of the pit every time an ingot is introduced or removed. A great amount of heat is therefore allowed to go to waste during this interval.

Next in the order of development comes the horizontal heating furnace. This consists of a long narrow passage with a bridge and combustion chamber at one end, the other end being open and provided with a sliding door. This furnace may be direct fired, or may use gas furnished from an outside source, as desired. Into the open end of this furnace, the ingots, after being turned to a horizontal position, are pushed, one by one, generally by means of a hydraulic apparatus. As they approach the combustion chamber they gradually become heated to the required temperature. Here they are removed through a cover in the top of the furnace. To facilitate the pushing operation, the furnace is provided with two water pipes laid longitudinally in the bottom, on which the ingots rest during their passage.

This furnace is compact, and, comparatively speaking, may be cheaply constructed and maintained. It posseses, however, certain disadvantages. First, if the ingot is not entirely solidified inside, upon turning it down to a horizontal position the molten metal may break through the thin crust at the top and run out. Second, while passing through the furnace the ingots are of necessity packed closely together side by side; consequently, the upper side alone is subjected to the direct heat of the burning gases. On the other hand, if the ingots approaching the firebox become welded together on account of excessive heat, as sometimes happens through careless heating, they are particularly difficult to separate.

A consideration of the inherent defects of the two methods of heating ingots just outlined has led to the development and construction of the vertical heating furnace, and later to its most recent adjunct, the electrical pusher. To describe this latest type of furnace in detail, and to disclose its method of operation, is the specific purpose of this paper.

In the accompanying cuts, Fig. 1 shows a semi-sectional plan and a sectional elevation of the furnace as arranged

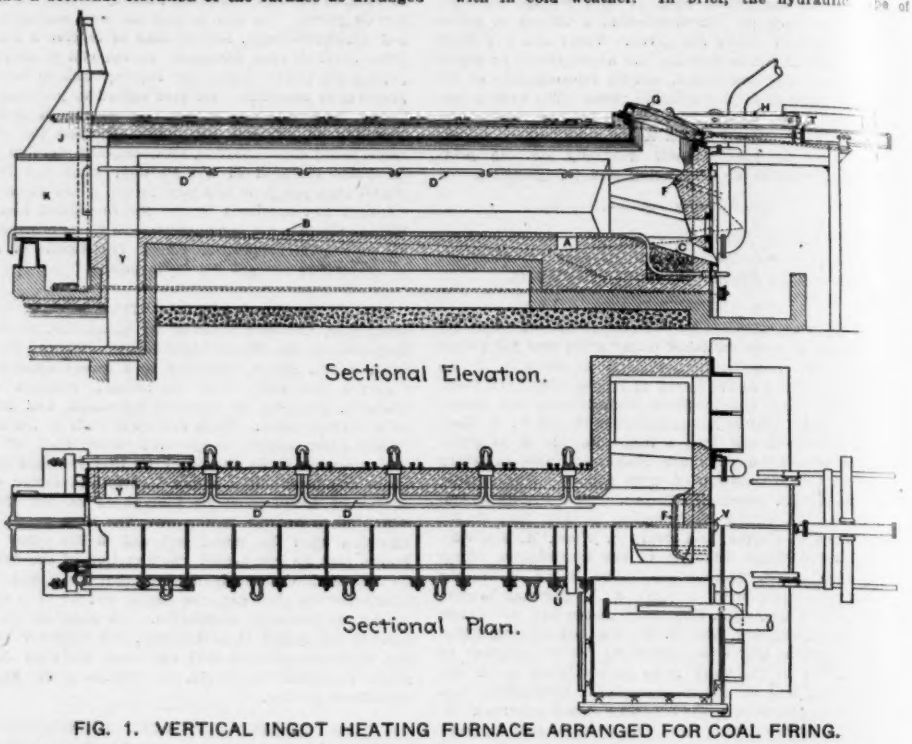


FIG. 1. VERTICAL INGOT HEATING FURNACE ARRANGED FOR COAL FIRING.

for direct firing, also an elevation of the charging end, and a semi-sectional elevation of the firing end.

The main body and the combustion chambers of the furnace are constructed of fire brick as is usual. Raised from the floor of the furnace, which, as may be noticed, slopes gradually from each end toward the opening A, is a fire brick wall. The latter carries a heavy wrought-iron pipe B, in which water is continually circulating. Two pipes may be used so as to give more of an incline to the ingots if deemed necessary. At the firing end of the furnace is a pit C filled with sand, which produces a fluid and free running slag, serving also as a hot bed for the removal of the cold spot on the base of ingot due to contact with pipe B.

In the side walls of the furnace the pipes DD are introduced as shown. These are inserted in sections, ends of which are firmly clamped outside of furnace, so as to secure a rigid support for ingots which lean against them, as later described. At the firing end of the furnace a pipe F is let into the wall as shown, to serve as a support for the ingot about to be withdrawn. The type of firebox and bridge, and the arrangement of blast pipes, are clearly shown, and need no further explanation.

Directly above the point where the ingot, having been pushed gradually toward the firing end, must finally rest, is placed a cover G. As will be noted on the drawings, this cover carried on truck H, rolling on rails T, is inclined to the plane of motion, thereby obviating the necessity of lifting before uncovering opening as is the usual pit practice. The operation of opening and closing the cover is performed by means of the pneumatic cylinder I, the piston rod of which is directly attached to the cover as depicted.

The charging end of the furnace is provided with projecting castings JK, serving the purpose of a receiver in which ingots are placed in proper position before entering furnace. The upper casting J carries a pair of brackets and rope sheaves; over these pass wire ropes from which is suspended door M, operated rapidly by means of air cylinder N.

The gases escape through the flues YY, which are so arranged that the draft will be equal on both sides of furnace. If desired, these flues may contain devices for heating the air blast.

The most interesting and novel feature in connection with the operation of the furnace is the pusher. In previous arrangements hydraulic pushers have been used; these are, however, open to several serious objections. It has been found impracticable to construct a single-stroke pusher of sufficient length to charge a furnace of this type, and as with the multiple stroke pusher [length] of stroke is limited, it is necessary when r[unning] the pushed head far into the furnace to take [num]ber of successive "hitches"—that is, the [plunger] after making a stroke must be run back [and a] fresh hold taken on the pushing bar by means o[f clutch]. The process is consequently very slow, and th[e door of] the furnace must remain open a long time. Wit[h the high] pressure necessary for handling large ingots, sa[y 12 x 12] ins. and above, considerable trouble is experienced in keeping the hydraulic connections tight and in [need re]pair. The pushers are also generally in exposed [positions], and unless carefully protected, trouble is liable to be met with in cold weather. In brief, the hydraulic [type of] charger has been found inadequate to furnaces of this length owing to its inherent weaknesses, viz.: lack of speed and danger of breakage due to water hammer under high pressure.

To obviate these difficulties, an electrical pusher has been devised. This consists essentially of a long I-beam, O, running upon rollers as shown, and provided with a cast-steel pushing head P. On the lower portion of the I-beam is bolted in section a cast-steel rack Q, the teeth of which engage with those of the pinion R, the latter being driven through a train of gears by the motor S. The latter is a series motor of the railway type and is arranged for the ordinary system of series-multiple control. The speed of the pusher may consequently be varied over as wide limits as desired, this feature being particularly desirable in rapidly withdrawing the ram from furnace. Considered from an economical point of view the electrically-driven charger is pre-eminently adapted to the purpose as the output of power necessary is in direct proportion to the effective work done. An auxiliary motor may be connected direct with the main driving gear, or independent on the pusher rack Q.

Briefly described, the operation of the furnace is as follows: The ingots one by one are placed by the charging crane so that they stand on the pipe B, the upper part resting against the rod L as shown in Fig. 3. They are alternately inclined to the right and left as indicated in the same figure. As fast as they are placed in position, the door M is raised and the ingots are pushed into the furnace. As the heat increases gradually toward the firing end, they reach the proper temperature as they approach the latter place. When the ingot reaches the incline part of pipe B it slides down and rests on the sand bottom C, the upper part leaning against pipe F, which locates the ingot in correct position for withdrawing. The cover G is then opened and the ingot, which is now ready for the rolls, is extracted in the ordinary manner.

It will be noted that slag holes are provided on each side as shown at U and also at the end as shown at V, the floor of the furnace being graded accordingly.

This furnace, as equipped, possesses a number of commendable features, as follows:

(1) Comparatively low first cost of installation.

(2) Considering the storage and heating capacity of this furnace, it occupies relatively a small floor place, besides being easily and quickly erected.

(3) Owing to the simplicity and accessibility of parts, the cost of repair and maintenance is reduced to a minimum.

(4) In the continuous furnace, especially the type which forms the subject of this paper, in which the ingots are

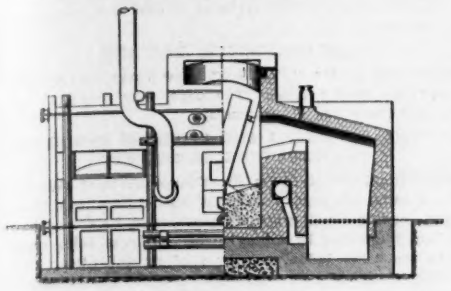
*A paper presented at the Milwaukee meeting (May, 1901,) of the American Society of Mechanical Engineers.

†Chief Engineer, American Steel & Wire Co., Worcester, Mass.

alternately inclined to the right and left, coupled with the continuous method of charging, a much better opportunity is given for an even heating on their sides, and in this respect the vertical furnace surpasses the horizontal and closely approaches the soaking pit; the even heating of ingots being one of the strongest arguments in favor of the latter.

(5) There is at all times a maximum amount of metal in the hottest region of the furnace, which is not true of any other type of ingot heating furnace.

(6) If, as often happens, it becomes necessary to charge cold ingots, the superiority of the vertical continuous heating furnace over all other forms is very marked, for its length is such that, after traversing say half the length of hearth, it is safe to say the temperature of the flame is about the same as when leaving the regenerative chambers of soaking pits. As a result, heat which escapes in the latter case is doing effective work in the continuous furnace preheating cold metal.



Firing End.
Sectional Elevation.

(7) As a consequence of the gradual decrease of temperature toward the charging door, cold ingots may be introduced into furnace without danger of cracking, thus giving to this type of furnace a decided advantage over the soaking pit form in the treatment of high carbon steels.

(8) The temperature of the burning gases decreases gradually from the firing toward the charging end, until, at the latter end, they are comparatively cool. Thus the opening of the charging door does not result in great loss of available heat, as in the case of the soaking pit.

(9) On account of the high speed of the pusher, the door is kept open a comparatively short time, and the pusher itself is only briefly subjected to the intense heat.

(10) The ingot is handled in a vertical position from the time it leaves the steel mill until it is delivered to the mill tables. No high pressure water is required in connection with this furnace, as air cylinders are found entirely satisfactory for operating the necessary doors and covers. Troubles incident to cold weather and maintenance of such a system are thus avoided.

(11) Owing to the method of applying the heat, it has been demonstrated in practice that the furnace waste and oxidation, or scale formation, is very much less in the vertical furnace than in the ordinary soaking pits.

(12) Another advantage over the soaking pit practice is that segregation is greatly reduced because in charging hot ingots the low temperature in the rear end of the furnace gives the inside core of the ingot a chance to solidify without losing the benefit of the initial heat in the ingot; and, furthermore, cold ingots that are already solidified can be charged in this furnace with greater economy, owing to the feature mentioned in paragraph (6).

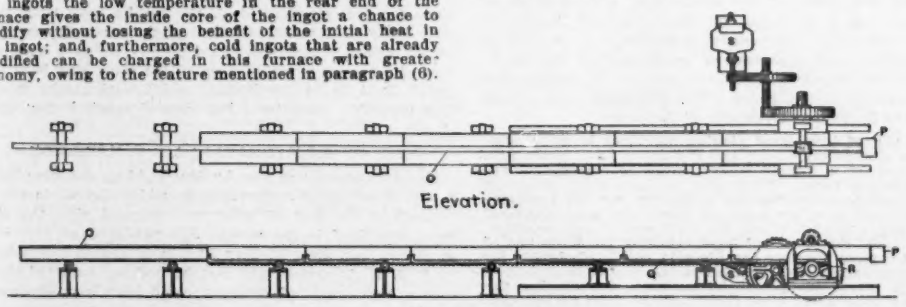


FIG. 2. PLAN AND ELEVATION OF ELECTRICAL PUSHER FOR INGOT HEATING FURNACE.

In conclusion, while this system of heating is advantageous in large plants, it seems to the writer to be especially adaptable to smaller plants producing from 100 to 200 tons of steel per day. In other words, for small size plants it seems apparent that a soaking pit arrangement would be comparatively very expensive.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The 43d meeting of the society was held at Milwaukee, Wis., May 28 to 31, the headquarters and place of meeting being at the Plankinton Hotel. The meeting was largely attended, nearly 350 members and guests being registered.

At the opening session on the evening of May 28, Prof. Warren S. Johnson, Chairman of the local committee, delivered an address of welcome, in which he showed the importance of the city as a manufacturing center, especially in various lines of machinery. This was responded to by Mr. Samuel T. Wellman, the President of the society.

The first paper was presented by Mr. W. S. Aldrich (Champaign, Ill.) on "Requirements of Electricity in Manufacturing Work." We printed this paper in our last week's issue. As there was some hesitation in starting the discussion, the next paper was at once presented by Mr. John Riddell (Schenectady, N. Y.):

PORTABLE VERSUS STATIONARY MACHINE TOOLS.

This brief paper showed the advantages, especially with very heavy pieces, and where several operations are required, of taking the tools to the work instead of the work to the tools. This ensures better results in less time and at less cost than when the work has to be handled, placed, adjusted, etc., several times. It also often enables two or more tools to work on the same piece at one time. The General Electric Co.'s machine shop has an immense bedplate in the floor, upon which the work is clamped, and portable tools are set in any desired position by the overhead crane.

The discussion of the two papers which followed dealt almost entirely with the question of power transmission by electricity, as compared with belts and shafting. Prof. D. C. Jackson (Madison, Wis.) said that in some cases of comparing electrical with mechanical systems of transmission, too much importance had been given to the question of economy in the coal pile, whereas the electrical system has so many advantages that its use would often be advisable even were the power-plant expenses greater. He referred also to the methods of driving machines independently or in groups, and advised that in small shops the groups should not consist of similar tools, but of different tools, as for instance, a planer, lathe, drill, etc. The regulation will eventually be by the motor control system, even back gearing being dispensed with. Where this system is not adopted, the application of electric transmission will be somewhat limited. Another member remarked that while the papers and the discussion referred mainly to machine tools and machine shops, there were other departments of large works where electric transmission is equally important. Motors are very convenient, they can be placed in out-of-the-way corners, and can be operated economically at long distances from the power station.

Mr. Aldrich showed that the great value of the electric transmission was in giving the workman a control over his machine and an independence of action which the belt system cannot give. This results in increased production, so that an old tool converted from belt to electric transmission will often show a much greater output than a new and modern machine driven by belting. With the electric system, also, it becomes practicable to work the machine up to the "destructive limit" of the cutting tool. Mr. W. S. Johnson explained the system of electrical control on printing presses, where push buttons at different parts of the press enable the operator to start, speed up, slow down, or stop the press without having to return to one point each time. Mr. John Riddell, in closing the discussion, referred to boring machines and other tools which had been converted from belt to electric transmission, with a decrease in power required and an increase in rate of production. This increase was in part due to the very rapid acceleration of speed that is possible with the electric system.

On Wednesday morning, May 29, the Secretary, Mr. F. R. Hutton, presented the list of new members. He also read a report of the committee on meetings of the Junior Members, showing that the plan of having special meetings of this class of members has not been satisfactory. The plan of holding meetings of the society, other than the two semi-annual meetings, is now under consideration by the council.

SUPERHEATED STEAM.

Two papers on this subject were presented. The first of these was on "The Practical Application of Superheated Steam," by Mr. Geo. A. Hutchinson (Anaconda, Mont.), and was practically a compilation of much that has been presented in the foreign engineering papers; it described various foreign plants, but gave little information as to the results in steam efficiency. The second paper, by E. A. Foster, is given in abstract below:

We find the steam engine of the present day much more suited to the use of superheated steam than formerly. We now have mineral oils which will stand high temperatures without disintegration; stuffing boxes packed with metallic packing; cylinders and steam pipes covered with an efficient insulating material; the wearing surfaces of cylinders and pistons are machined to a nicety, and the interior surfaces often highly polished; we have improved forms of balanced and steam-tight valves, and these with our present searching after every device to make the engine more economical, seem to open a field for the superheater to an almost unlimited degree. In Europe we find much encouragement in this belief. We Americans have characteristically developed the line following the path of least resistance, practically ignoring the question of superheating, which had seemed to be set aside. The more heat supplied per unit of weight of steam to the engine the more work can be obtained from the engine, and the increase of pressure having a practical limit, this extra heat is to be obtained by superheating the steam. The diminished density of the steam employed to do the work lessens the back pressure, or, as commonly expressed, improves the vacuum. This also applies to the air and vapor which are carried with the steam and further expanded by the increased heat, and are consequently contracted to a much less volume when chilled by striking the cooling surface of the condenser; thus the air pump has less work to do.

The use of superheated steam is bound to have an important effect on the question of jacketing cylinders. If the superheating is sufficient to carry the steam through the engine to the point of final exhaust without reaching the saturation limit, there is evidently no use for steam jackets. The use of perfectly dry steam and the elimination of condensed water would seem to be very practical advantages of superheating.

As the friction for superheated steam is much less than for saturated steam, there is not so much loss in ports and passages, and the size of the pipes may be considerably reduced. The tendency in this country has been to use steam pipes which are much too large. Good practice with superheated steam recommends that the velocity should not be less than 100 ft. per second passing from the boiler to the engine. In European practice we find no prominent central station designed without providing for superheated steam; engine builders make guarantees contingent upon it, giving an advantage averaging about 12% in lbs. of steam per HP. based upon the steam being superheated. The range of temperatures has resolved itself into recommending the use of steam at between 500° and 600° F. Experimenters have observed that steam expands more rapidly during the first 20° of superheating than when further raised in temperature; consequently the first effects are proportionately more beneficial.

Dismissing the subject of superheating by means of wire drawing as being inefficient and impracticable, the methods resolve themselves into a system of tubes or pipes, through which the steam is passed after leaving the boiler on its way to the engine; these pipes being subjected to the hot furnace gases, either in connection with the steam boiler itself or in a separate setting having a fire of its own. In large plants it is usual and even more desirable to set the superheater by itself; and it is placed alongside of the boiler as a continuation of the battery, with fronts and setting similar to the boilers, and fired in the regular manner. The fact that the results are found to justify such an addition to the plant is the best testimony in favor of superheating.

Much rivalry exists between the use of cast-iron and wrought-iron tubes for superheaters, and there seem to be well-defined governing conditions in different instances where either one or the other is found the more desirable. For general use, however, the cast-iron construction possesses greater durability, and the greater mass of heated metal serves to maintain the temperature of the steam at a more even point, regardless of not being so much affected by the working of the fire.

The wrought-iron construction for superheaters undoubtedly has its useful field. The lightness and compactness of this form of apparatus are greatly in its favor. With well assured circulation, a comparatively low temperature of hot gases, and especially where a moderate degree of superheating is required, good results should be obtained.

Aside from its application to steam plants where the engine is in close proximity to the boiler the superheater has an immense field as a relay agent. In large plants where steam is conducted from one central boiler plant to other buildings, often at a considerable distance, a superheater with a comparatively small gas, oil, or coke fire may be placed at the far end of the pipe and add enough heat to the steam not only to evaporate all the moisture produced by loss of heat in transit, but to raise the temperature to such a degree of superheat as to increase its efficiency in the engines as before mentioned.

We believe the superheating of steam will give the triple-expansion engine somewhat of a setback. We have records of tests under which a compound engine with superheated steam has given better results, under similar conditions of work, than a triple expansion.

In the discussion, Prof. W. F. M. Goss (Purdue University) remarked that the German simple locomotives fitted with superheaters are found to use no more steam per horse-power hour than compound engines. He considered that American engineers had long ago recognized both the advantages and difficulties of superheated steam, and believed that the same ends can be better obtained by other means. Prof. Storm Bull (University of Wisconsin), however, believed the author was right in saying that American engineers have generally ignored the matter. It is not a question of superheating versus jacketing and compounding, but of superheating in addition to the other methods of economizing in steam consuumption. The main question is whether superheating is a paying investment. Other members referred to tests to be made in Chicago and to a mill at Wilmington, Del., where part of the steam is utilized at a distance of 600 ft. from the boilers. At the end of the steam pipe is placed a superheater, resembling a vertical boiler, with a small fire.

DRAFTING ROOM AND SHOP SYSTEMS.

This was the subject of the next paper, by Mr. F. O. Ball, and an abstract of which we shall give later. It described methods of arranging tracings and blue prints for shop use, and also methods of keeping shop orders, pattern shop records, labor cost records, etc. In the discussion, three or four members objected to making the drafting department so all-important as recommended by the paper. This department is largely a bureau of records, and should not be an absolute authority, as much good designing may originate outside. Nor should the drafting room be made responsible for the design of patterns; that is the pattern-maker's business, and he will discover difficulties in making certain patterns long before they would be discovered in the drafting room. A decimal system of numbering patterns, allowing of a very thorough classification, was suggested by Mr. J. Sellers Bancroft (Phila-

delphia), and is in use by Wm. Sellers & Co. Mr. Ball's idea of having a separate sheet for each part of a machine was objected to by several members, as it requires too many blue-prints. A proper grouping of the parts, with a system of numbering and classification of parts, is much to be preferred, and is much simpler. One member said that in his works, the number of drawings per machine averages 1½, while under Mr. Ball's plan six sheets would be required. He described in detail his system of numbering and indicating the various parts.

BLUE PRINTING BY ELECTRIC LIGHT.

A paper on this subject was presented by Mr. H. G. Reist (Schenectady), and described the apparatus used by the General Electric Co., which was illustrated in our issue of May 23. Some further particulars as to the time and cost of the work were given in our issue of May 30.

In a written discussion by Mr. Blood it was stated that electric blue printing is quite common in England, where apparatus for the purpose is advertised in the engineering papers. He considered Mr. Reist's frame too cumbersome and expensive, and presented a drawing of a more convenient method in which a light frame is set at an angle, with its lower edge resting on the table and its upper edge attached to the hood of the electric light. Mr. C. W. Hunt referred to an apparatus consisting of a vertical glass cylinder, inside which is suspended an arc lamp and on the outside of which are applied the tracings and paper. It was also shown that this practice is specially advantageous in allowing reproductions to be made immediately without regard to the weather.

RULES FOR DRAWING OFFICES.

An abstract of this paper by Mr. A. W. Robinson was read by the secretary. No discussion followed. An abstract of the paper was given in our issue of May 30.

INFLUENCE OF TITANIUM ON THE PROPERTIES OF CAST IRON AND STEEL.

The secretary also presented an abstract of this paper by Mr. Auguste J. Rossi (New York), which has already been published in our issue of May 30. The paper was taken up for discussion at the session on May 30, when Mr. Rossi was present and exhibited some samples of ores, pig iron, and tools made from this metal. Mr. Hugo (Duluth, Minn.) and Mr. Wellman (Cleveland, O.) enquired as to the possibilities of the commercial use of the vast deposits of titaniferous ores in Minnesota, but on this point Mr. Rossi was not able to give any very satisfactory reply.

At the morning session on May 30, the first subject taken up was the preliminary report of the committee appointed to codify and standardize the methods of making engine tests. The report itself was brief, and some extracts are given below, but it was accompanied by detailed rules and instructions for the carrying out of tests on steam and gas engines, with a blank form for data and results.

STANDARDIZING ENGINE TESTS.

The only unvarying unit expressive of the energy consumed is the "heat unit," and we believe it is a foregone conclusion that the standard of consumption for all heat engines should be referred to heat units.

The unit of mechanical power, almost universally adopted, is the "horse-power," and by common agreement it is a satisfactory unit expressive of the power developed by an engine. If it were possible in every case to determine the useful power delivered by an engine, or what is termed in some instances the "brake horse-power," there would be good ground for making this the unit, but such determinations are rarely feasible; on the other hand, it is not always possible to obtain the indicated horse-power, as for example, in the case of steam turbines. It is therefore necessary to employ two units to meet all possible cases: the indicated horse-power and the brake horse-power.

The expressions of engine efficiency which meet both the requirements noted, are the number of heat units consumed per hour, both per I. HP. and per brake HP., and these we recommend as the desired standards of comparison. The heat unit standard does not interfere in any sense with the common terms of expressing efficiency of engines. The hourly weights of coal, gas, oil, or other fuel, or weight of steam, consumed per HP., heretofore commonly employed, are additional forms of stating the efficiency, and are none the less useful within their limitations. They should by no means be abandoned. Neither should the standard forms recommended for expressing the duty of pumping engines, or the efficiency of locomotives, previously accepted by the society, be changed. The heat unit standard makes it both desirable and obligatory to charge the engine with the steam used by necessary auxiliaries, for the reason that it is itself finally benefited by the heat which they return. The heat consumption of gas, oil, or other engines of the internal combustion class, is found by ascertaining the total heat of combustion of the particular fuel used (which should be determined by a calorimeter test), and multiplying the result by the quantity of fuel consumed.

The I. HP. for the proposed standard is that determined by the use of steam engine indicators. It should be confined to the power developed only in the main cylinder or cylinders.

The heat consumption of a steam engine required for the standard test is ascertained by measuring the quantity of steam consumed, calculating the total heat of evaporation of the entire quantity, and crediting this total with that portion of the heat rejected by the engine, which is utilized and returned to the boiler.

We have embodied the British standard in our plan as one of the subsidiary forms of expressing efficiency, with the exception that we recommend that the heat returned to the boiler be taken as that corresponding to the temperature of steam at atmospheric pressure for non-condensing engines and to the vacuum in the condenser for condensing engines, in place of that correspoding to the pressure in the exhaust pipe.

We have chosen as one of the important subsidiary forms of expressing efficiency, that based on a so-called "standard coal" unit, referring to coal which imparts to the steam 10,000 B. T. U. per lb. of dry coal consumed. It is coal having a calorific value of 12,500 B. T. U. used in what may be termed a "standard boiler," which gives an efficiency of 80%.

We are aware that engine testing is a species of scientific investigation, and there is a tendency, among those interested in it as such, to lose sight of the fact that the practical result which the engine secures for the owner or party using it is the one thing of highest importance. We have endeavored to secure a plan of such breadth that whatever the special object of the engine test, whether it be a scientific investigation, a practical determination of everyday performance in the interest solely of the owner of the engine who must defray the expenses of its operation, or a test in the interest of the engine builder with the object of showing the capability of the machine and using this information for purposes of advertising and trade, it will prove sufficient and suitable for all.

To make the work complete, attention has been given to the subject of commercial tests of steam engines; that is, to coal tests of the combined engine and boiler under conditions of commercial use. Such tests are of the greatest importance to the user of a plant, and they demand consideration. When a steam engine is operating at its rated power at a given pressure there should be a sufficient reserve to allow a drop of 25% in the gage pressure without sensible reduction in the working speed of the engine.

The discussion was limited. Dr. R. H. Thurston, in a letter, stated that the British committee on heat units was not very logical in its conclusions, but that the present committee on tests was wise in accepting them, to avoid controversy or confusion. He also referred to the different kinds of "efficiency." On motion of Mr. C. W. Hunt, a resolution was passed requesting the council to consider the advisability of having blanks printed for records of tests, as prepared by the committee, the blanks to be furnished to members at cost.

STANDARDIZATION OF ENGINES AND GENERATORS.

A progress report of the committee on this subject was then presented by Mr. J. B. Stanwood (Cincinnati), showing that the work has had the hearty co-operation of engine and dynamo builders, while the preliminary report has been approved by the Engine Builders' Association. Recommendations have been made as to certain dimensions, the speed, and the overload capacity. In actual practice this capacity ranges as high as 50% or even 100%, but the report will recommend that for standard machines it be limited to 25% of the rated capacity.

Some additional remarks on titaniferous iron were then made by Mr. Rossi, as already noted.

INSTRUMENTS OF PRECISION AT THE PARIS EXHIBITION.

This paper, by Mr. W. E. Reed (Cleveland), described some of the notable telescopes (including the great Deloncle and Gautier fixed telescope with 6¼-ft. mirror) and astronomical apparatus shown at Paris last year. Various other exhibits in the same line were also described.

BEVEL GEAR CUTTING MACHINES AT THE PARIS EXHIBITION.

This paper, by Mr. Fred. J. Miller (New York), was a detailed description of the construction and operation of the machines referred to, and was very fully illustrated. In the discussion one member remarked that in view of the delicacy and exactness of work required the workmanship on some of the machines was not in keeping with the character of the design. The following is an extract from the introductory remarks of the paper:

> The use of bevel-gear planing machines is more common in Europe than here, and the use of bevel gears with teeth cut by a formed rotary cutter is correspondingly less common there. They seem to have more generally recognized the fact that in order to get a properly-shaped tooth in a bevel gear it must, generally speaking, be planed, and that where the teeth are of any considerable length, the errors of form resulting from the use of formed cutters are very considerable, and inadmissible for what may properly be regarded as the best work.
>
> At the Paris exhibition six machines for planing the teeth of bevel gears were shown, all of them noteworthy, and in one way or another interesting, most of them differing one from the others as much as it would seem to be possible for them to differ, in view of the fact that all were for the same purpose. Of these machines one was English, two French, two Swiss and one American. Another American machine described in the paper does not plane the teeth, but mills them, though it does not use a formed cutter, but copies a generated tooth curve by a cutter having a plane cutting surface. Only two of the gear planing machines generate the tooth; all the others copy a tooth template or pattern.

THE LOCOMOTIVE EXHIBITS AT THE PARIS EXHIBITION.

This third paper on the Paris Exhibition of 1900 was by Prof. Storm Bull (University of Wisconsin), and was very voluminous, describing the various engines and giving a great number of reproductions of views and drawings. From the general discussion of the exhibits we take the following brief extracts:

> The first strong impression that an American would get by viewing the European locomotives was that their size had been very greatly increased during the past few years. This is especially true of the passenger engines. Fully half of the locomotives were compounds, of every conceivable design and combination. About half the engines now built in Europe are compounds, and the opinion that the compound is an advance beyond the simple engine is backed by nearly all competent authorities in Europe outside of Great Britain. Continental designers almost always adopt the Walschaert valve gear, and place it outside the frames. Of the 66 locomotives exhibited, France had 16; Germany, 14; Austria, 6; Belgium, 6; Switzerland, 5; Russia, 5; Great Britain, 5; Hungary, 3; Italy, 3, and the United States, 3. Of these 57 were of standard gage and 9 of narrow gages; 32 of the 57 were fast passenger engines. There were 34 compounds; 15 with two cylinders (9 passenger, 5 freight and 1 tank), 1 (passenger) with three cylinders, and 17 [illegible] four cylinders (14 for fast passenger and 3 for [illegible] service).

In the discussion Prof. W. F. M. Goss (Purdue University) called attention to the extensive introduction of the Von Glehn type of compound engine in Europe. In this type there are two inside cylinders driving a forward pair of axle, and two outside cylinders driving a rear axle. This gives perfect balancing and distributes the strains over a greater number of parts. The increase in number of parts has been commonly objected to in this country where simplicity has been the principal aim. But as the parts are smaller and lighter, are more equally balanced and are subjected to less severe strains than some of the enormous and heavy parts of powerful American engines, it does not necessarily follow that this increase means an increase in breakages or in cost of maintenance and repairs.

A NEW CONNECTING ROD END.

This paper, by Mr. C. W. Hunt (New York), was printed in our last week's issue. The paper was presented by title, and there was no discussion.

A METHOD OF FILING AND INDEXING ENGINEERING LITERATURE, NOTES, ETC.

The method described by Mr. George H. Marr (Waterville, Me.) in this paper consists of sets of envelopes, 6¼ x 10 ins., having binding strips on one edge, by which they are bound together in volumes, the envelopes being open at the top. The indexing is by subjects and titles. For keeping track of notes Mr. Marr uses the Morehouse notebook, with detachable leaves and index.

Prof. L. P. Breckenridge (University of Illinois) referred to the advantages and the general use of the decimal system of classification for indexing and filing. A card index of important publications is kept by the University of Illinois, and the Western Society of Engineers has a copy of this. He thought it very desirable to have a universal method (even if a poor one) rather than for each individual to make his own plan of filing.

On Friday, May 31, at the morning session, the first paper presented was by Mr. W. O. Webber (Boston) on

TESTS OF A CENTRIFUGAL PUMPING PLANT.

This paper had the misleading title of "A Filtration Plant at Albany, N. Y." The water is pumped to the filtration basin by two 24-in. Webber centrifugal pumps, directly connected to two vertical, cross-compound, condensing engines, with cylinders 10 x 10 and 18 x 10. The pumps have a guaranteed capacity of 16,000,000 gallons daily against 18 ft. head, or 12,000,000 gallons against 24 ft. From the pumping station the water passes through a 36-in. Venturi meter. In the test described the duty per 100 lbs. of dry coal was 40,610,000 ft.-lbs., or 56,708,000 ft.-lbs. for the main engine alone. The net efficiency of the pump alone was 77%.

Mr. E. T. Adams (Milwaukee) said that while the conditions for the test were ideal, the results were poor, the duty being very much less than might reasonably be expected with a properly designed plant. He gave particulars of a sewage pumping plant of the same kind built by the E. P. Allis Co. for Boston, which works under much less favorable conditions, but showed much higher efficiency.

TEST OF AN HYDRAULIC AIR COMPRESSOR.

The next paper was also by Mr. Webber, and described a test of a Taylor compressor, in which the air is compressed by the flow of water in a vertical pipe, the air being entrained in the water. We published an abstract of this in our issue of May 30. In a written discussion Prof. R. H. Thurston said that he had not expected that such a high degree of efficiency could have been obtained by this system.

THE BARDWELL VOTOMETER.

Voting machines are of mechanical and political interest, and this paper, by Mr. A. F. Bardwell and Mr. James Hamilton (Boston), described the machine invented by the former and now in somewhat extensive use. The machine consists of an interlocking registering and recording apparatus, the face of which forms the ballot, the voter turning a small key in the compartment for each person or question for which he casts a vote. Any desired combination can be made, and any changes made before the vote is registered by the final movement, but the interlocking prevents the casting of more than one vote.

The voter finds upon the face of the machine the names of the various parties and candidates arranged, either alphabetically or in party order, together with the questions, etc., that comprise the ballot. The top horizontal row is devoted to the "independent" feature (or card delivery), by which a voter may vote for an individual whose name does not appear upon the ballot.

The voter may make any legal selection he wishes. If he desires to cast by a single half-turn of the key a vote for all the nominees of a party, he confines himself to the "straight ticket" section, and inserting the key in the proper hole (which is in the center of the label bearing the name of the party for whose candidates he wishes to vote), he gives it a half-turn to the right, the limit of its motion. The effect of this is positively to actuate the register at the back. He cannot withdraw the key until he has completed a half-turn, and therefore registered his vote beyond peradventure. Simultaneously with the turning of the key an indicator cross appears at the right of the keyhole, showing at a glance where he has voted. It is now impossible to turn the key in any other hole in that section—that is, to vote an additional "straight ticket"—and it is also impossible to vote on a register as-

signed to an individual on the same ticket, or to cast a vote on any other ticket.

In a written discussion by Prof. R. H. Thurston (Cornell University) it was explained that a number of States already have laws permitting the use of voting machines. In New York State there are 250 Bardwell machines, several of which are in Buffalo, but none of which (it is hardly necessary to say) are in use in New York city. Mr. Hugo (Duluth) stated that in Duluth there is a large foreign population, which barely understands the present system, and can only vote under the Australian ballot when instructed by means of facsimiles of the ballots marked exactly as their instructor desires them to mark the ballots. He thought the voting machine would be utterly bewildering to this class of people, and he also referred to the great cost of purchasing, storing and repairing for the machines, though he recognized their importance. Mr. Gus Henning remarked that the illiterate class referred to might be instructed by diagrams of the face of the machine, which remark led to some pleasantries respecting political engineers and mechanical engineers.

The next paper was one by Mr. Francis H. Stillman (New York) on

"A PULLEY PRESS VALVE."

This valve is believed to be one of the most elaborate ever used to operate the motions of a single hydraulic press. The conditions were that of serving quickly a press having cylinders working from six directions, and aggregating about 2,500 tons. The work to which these presses are devoted is the manufacture of the American Pulley Co.'s all-steel pulley rims.

The motions of this press when doing no work are a considerable part of the whole, while the motions requiring the heavy pressure are very short. The economy of operating under such conditions is obtained by low and high pressure accumulator service of 150 and 1,000 lbs. per sq. in., augmented by two intensified pressures. These latter are obtained by one variable intensifier working at 2,000 lbs. and 3,000 lbs. pressure. The change of pressure obtainable by the latter is secured by locking an intermediate ram either to the high pressure ram or low pressure cylinder.

This press-controlling valve is started in motion and stopped and returned to the starting position by means of auxiliary valves. One of these is placed in connection with each side of the main valve, one set governing the vertical and the other the horizontal cylinders. A good operator can handle both of these starting valves at practically the same time, as actual working condition will retard the vertical pair of cylinders enough for the horizontal ones to grip the work before the bending action of the former begins.

Each starting valve is a disc valve having a large spherical metallic seat. These valves throw the low pressure accumulator service to differential double-acting low pressure operating cylinders. All of the vertical valves in this combination are of the balanced spindle type.

EXPERIMENTS ON BALL STEP-BEARINGS.

This paper, by Mr. C. H. Benjamin (Cleveland, O.), was given in abstract in our issue of May 30, and showed that under heavy pressures and long continued wear such bearings are very uncertain, while the pressure must not approach anywhere near the crushing strength of the balls. Prof. Gray sent a discussion describing similar tests on ball thrust bearings, which showed very great irregularity in the dynamometer records, owing largely to lack of uniformity in the quality of the balls. Mr. C. W. Hunt also spoke as to the unpromising character of such bearings, owing to the low pressures to which the balls must be limited.

DETERMINATION OF FLYWHEEL TO KEEP THE ANGULAR VARIATION OF AN ENGINE WITHIN A FIXED LIMIT.

The mathematical character of this paper, by Mr. J. I. Astrom (Helsingfors, Finland), prevented any general discussion, but Mr. W. L. Abbott (Chicago Edison Co.) described in detail a method used by him in testing the variation of angular velocity on a 3,500-HP. engine, the method being somewhat less analytical than that of Mr. Astrom. One member questioned the practical value of such intricate investigations, but Mr. Abbott replied that as the speed of an engine is stipulated within very close limits by the builder of a dynamo, it is important for the engine builder to get the weight of his flywheel as nearly exact as possible. Mr. Chamberlain (Chicago) described a method used by which a pointer traced loops on the whitewashed face of a band wheel, the variations in the length of the loops indicating the variations in speed.

The last paper of the morning session was by Mr. W. S. Russell (Detroit):

A SPECIAL FORM OF BORING AND FACING MACHINE.

This tool was got up to face the flanges of a number of cylinders 13 ft. diameter and 3½ ft. high. A mill for this work could not be obtained within several months, but this machine was made in 25 working days. It weighs 34,000 lbs., but is portable, resting merely on the floor of the shop. The mill has a vertical cylinder, on which is mounted a revolving plate holding four cutting-heads. The upper edge of the cylinder projects inward to form a flange; the lower edge projects inwards also to form seats for the brackets of the driving mechanism, and outwards to form a base to which castings to be finished are secured. The machine fits inside the cylinder to be faced.

At the evening session a paper was presented on "Efficiency Tests of a 125-HP. Gas Engine," by Mr. C. H. Robertson (Lafayette, Ind.). This was supplementary to a similar paper presented to the Society in 1899, and an abstract is given on another page of this issue.

BALING COTTON IN ROUND BALES OF UNIFORM LAP.

This paper was presented by the author, Mr. John B. Fordyce (Little Rock, Ark.), who has been designing and building machines for this work for six years. The paper described the advantages of round bales in cleanliness, no weight of iron hoops, ease of transporting and warehousing, and greater density, with less danger from fire owing both to the density and the secure wrapping. The baling press weighs only 15,000 lbs., as against 300,000 lbs. to the square bale press, and requires no separate ginning. The aggregate of the savings due to the use of round bales is estimated at 4-5 ct. per lb. of cotton. In winding the bale the pressure is varied so as to give a uniform density throughout. Besides the baling press, there is a machine for opening and unwinding the bales at the mill.

PROTECTION OF FERRIC STRUCTURES.

This was a lengthy paper on paints and preservative coatings by Mr. M. P. Wood (New York), and we shall give some extracts from it later. A written discussion from the Dixon Crucible Co. disputed a number of the statements made in regard to graphite. Prof. D. C. Jackson (University of Wisconsin) referred to tests made by him which indicate that in iron and steel members the corrodibility increases directly with the strains to which the members are subjected, although this is at variance with much that has been published. Metals which do not change their characteristics under strain do not change their corrodibility. Another member referred to the Chrysolite paint, made by the Solvay Process Co. from the tar from coke ovens.

AN IMPROVED TYPE OF INGOT-HEATING FURNACE.

This paper, by Mr. F. H. Daniels, was the last of the meeting. It is printed on another page of this issue. Mr. Wellman (Cleveland) stated that one of these furnaces, now in use, gives very satisfactory results. Its main advantage is its economy in fuel, the consumption being only about half that of the ordinary furnaces.

The President, Mr. Wellman, then announced the appointment of a committee to nominate officers to be voted for at the next annual meeting. This committee is composed of Messrs. R. W. Hunt, Walter C. Kerr, Fred. H. Daniels, Harris Tabor and C. H. Benjamin. The secretary read an amendment to the constitution, which will be presented at the annual meeting, raising the annual dues from $15 to $25 for members, and from $10 to $15 for juniors. The initiation fees will remain unchanged. The cost for a life membership will be $350. After passing a series of resolutions of thanks for the entertainments provided and the various courtesies shown, the meeting adjourned.

ENTERTAINMENTS AND EXCURSIONS.

The first of the numerous entertainments provided was a "smoker" in the main dining room of the hotel after the opening meeting, on May 28, which afforded opportunity for members to make or renew acquaintances. At the same time a reception for the ladies was held in the parlors. In the afternoon of May 29 special electric cars were provided and took a large party to the works of the Edward P. Allis Co. After a tour through the works one party proceeded to the plant of the Christensen Engineering Co., while another party visited the engine works of the Filer & Stowell Mfg. Co., the Vilter Mfg. Co. and finally the Nordberg Mfg. Co. At all these works the machine shops were very quiet, owing to the machinists' strike, but there was much to interest the visitors. The same afternoon an excursion to the Public Museum and Library was provided for the ladies.

A reception was given by the Deutscher Club at its clubhouse on the evening of May 29. On May 30 an afternoon trip was made by special electric cars to Waukesha, 20 miles, where carriages were in waiting to take the party to the numerous springs for which this place is noted. The day was so chilly and damp as to somewhat mar the pleasure of the excursion. Numerous other entertainments were provided for the ladies of the party during the meeting.

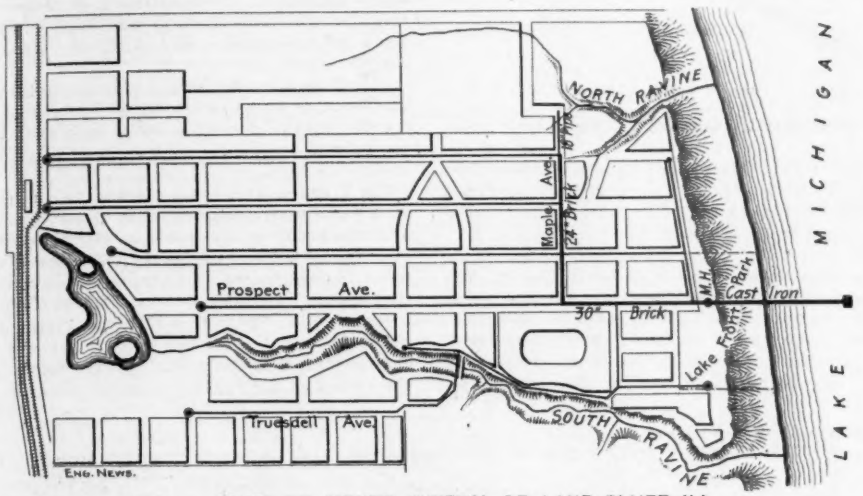


FIG. 1. PLAN OF SEWER SYSTEM OF LAKE BLUFF, ILL.
Engineer, W. T. Griffith, Lake Bluff, Ill.

THE SEWER SYSTEM OF LAKE BLUFF, ILL.

By W. T. Griffith.*

Lake Bluff is a small summer resort with a population of about 3,000 people. It is on the west shore of Lake Michigan and about 30 miles north of Chicago, and lies on a bluff about 75 ft. above the lake. Going west from the lake, the surface of the ground falls about 2 ft. to Maple Ave., and then has a general rise of about 25 ft. in the first ¾-mile, the contours, or ridges and hollows, running parallel with the lake. These are intercepted on the north and south of the village by deep ravines which head in the village and run down to the lake level at the bottom of the bluff. The streams at the bottom of these ravines are now but tiny rivulets. The principal streets run east and west from the railway to the lake, thus giving north and south frontage to most of the property, as shown on the accompanying map, Fig. 1.

In designing a system of sewerage for Lake Bluff, the writer decided on a combined system of sanitary and storm water sewerage as being the most economical, considering the frontage of

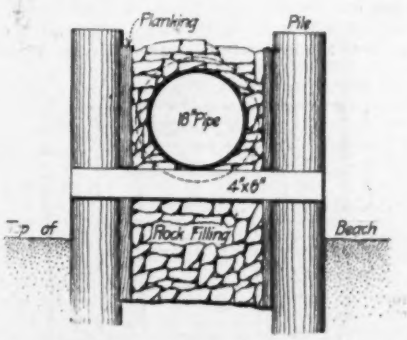


Fig. 2. Beach Crossing of Outfall Sewer at Lake Bluff, Ill.

the property, the character of the ground and the money available. To this there were strong objections by neighboring interests on the lake front, who sought to compel the village to put in some kind of a purification system, but the writer could see no good reason for this small village to go to the expense of purifying its sewage, before emptying it into the lake, so long as its larger neighbors were not doing the same.

*Civil Engineer, Room 211, No. 225 Dearborn St., Chicago.

Having decided this point, the next to be considered was an outlet, which at first glance would not seem difficult, as the two ravines form natural waterways. But here is where we met our troubles. Between these ravines there is about half a mile of bathing beach, and the owners of this, backed by the entire population of the town, insisted that this should not be spoiled by turning sewage upon it. A careful examination of the shore and the sand-bars near the shore, together with the currents forming them, convinced the writer that between the first and second bar there was a current to the south. This, of course, precluded the use of the north ravine. The next natural course was the south ravine. Accordingly, surveys were made and detail plans drawn for an outlet down this ravine. But for this route it was impossible to obtain the right of way, as the property owners succeeded in defeating the village in court.

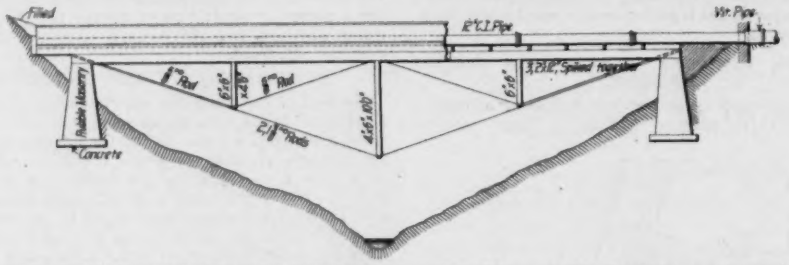


FIG. 5. FINK TRUSS SUPPORT FOR TRUSDELL AVE. SEWER OVER RAVINE; LAKE BLUFF, ILL.

Being cut off from both ravines through the legal objections of owners, there was left but one route to the lake; this was over the bank of the bluff, on property under the control of the village. Accordingly surveys were made and plans drawn for the outlet as it is at present constructed. The entire system consists of the following:

(1) Main outfall sewer, which is divided into three sections; A, iron pipe, cradle and crib, the latter located in the lake 275 ft. from shore line; B, a 30-in. brick sewer in eastern end of Prospect Ave.; C, a 24-in. brick sewer in Maple Ave.

(2) The street laterals, which vary from 18 to 8 ins. in diameter, and have grades of from 1 in 300 to 1 in 40.

The upper end of each street lateral is provided with a manually operated flush tank 4 ft. diameter, and connected with the water system so that in times of drought the system can be flushed; while in rainy weather the surface water coming into the 102 catchbasins will keep it well flushed. The principal items of construction that will be of interest are the iron pipe outfall, with its cradle and crib, and the crossing of the south ravine with the Trusdell Ave. sewer.

In order to protect the bathing beach as well as the park beach it was decided to carry the sewage out to the second bar, a distance of 275 ft. from the shore; to build a solid pier or breakwater into the lake would cause the sand to make new land or beach out into the lake, so that at the end of a year or two the sewage would be emptied on the shore; it was therefore decided to carry an iron pipe out on pile and open cradle work above the surface of the water, thus leaving the currents unobstructed. This has proved successful so far. The extraordinarily severe northeast storms of last fall have not made any unusual amount of beach around the pier.

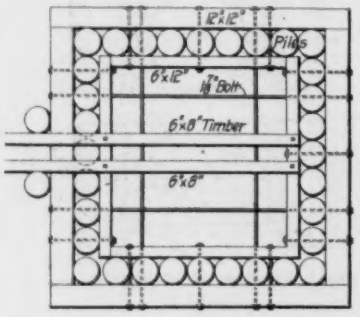


Fig. 4. Plan of Crib at End of Outfall Sewer.

The iron pipe outfall is of cast iron, 18 ins. diameter. It commences at the manhole at the edge of the bluff at an elevation of 55 ft. above the lake and is carried down the bluff in a trench to a point just above the beach, where it leaves the trench and is carried across the beach between two rows of piles and resting on cross pieces 4 x 6 ins. spiked to the piles. The rows of piles are planked on the inside and the space between them is filled with rock in order to protect the pipe from the huge ice banks that form every winter. Details of the beach crossing are shown in Fig. 2.

From the water's edge the pipe is carried in the open cradle work shown in detail in Fig. 3. The piles are of 10-in. oak, driven into the ground as far as possible with a 4,200-lb. hammer, the penetration being from 8 to 12 ft. The ground consists of from 1 to 3 ft. of sand underlaid with clay. The timbers are of hard pine, bolted together and to the piles with ¾-in. and ⅞-in. bolts. The rows of piling are 46 ins. c. to c., and the piles are 6 ft. c. to c. in the rows. After driving the piles the order of construction was as follows: The lower pair of cross pieces, A, 6 x 8 ins., were fastened to the piles and notched to receive the longitudinals, B, 6 x 8 ins., which form the bottom of the cradle; then the side pieces, C, 8 x 8 ins., were put in place and drift-bolted to the piles with ⅞-in. drift bolts. The bottom and side pieces were laid to break joints, were placed true to line and grade, and were notched to receive the bells of the pipe. Above the pipe are cross pieces, D; and four lines of longitudinals, E. The heads of the piles are cut to a wedge form to receive the ends of the diagonal timbers, G, which are supported by blocking pieces, F. Outside of the piles are the stringers, H; while a line of longitudinal braces, J, runs between the intersections of the diagonal braces.

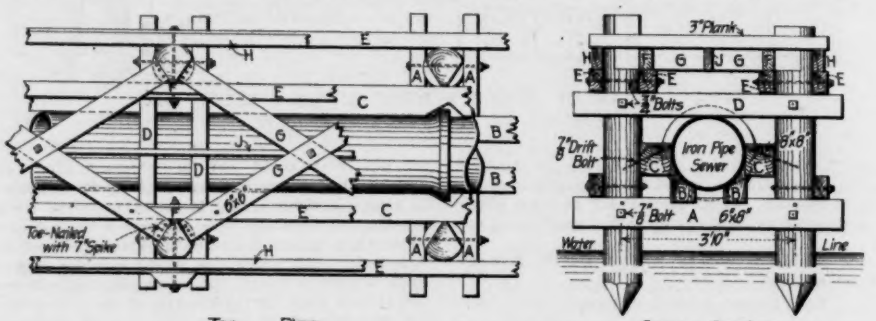


FIG. 3. TRESTLE AND CRADLE FOR OUTFALL SEWER.

The pipe laying was commenced at the outer end of the crib and carried inshore, the pipe being carried out on a "dollie" made to ride on the 8 x 8-in. timbers. After the pipe was in place it was leaded and calked. This proved quite a difficult task, as there was not room enough to "yarn" the lower half of the joint from the outside, so a thin string was worked in from the inside and that was plastered with wet clay. To run the lead, the "roll" was made in two pieces; one placed underneath and the other above the timbers, and clay was packed in the notches of the timber. Nearly a full joint of lead was run, and then the joints were calked on the upper half. This proved sufficient to hold most of the joints from leaking. A few joints which had not been properly filled with lead still leaked, and these were calked from the inside with cold lead. After the pipe was in place and calked the balance of the framing and the deck were put in place.

It will be noticed from the drawings that the diagonal braces, 6 x 6 ins., are notched into the tops of the piles. This was done to give a better bearing to support the ice which piles up as high as 30 ft. during some winters.

The outer end of the cradle terminates in a crib 10 ft. square constructed by driving piles close together to form a hollow square, as shown in Fig. 4. To these piles were bolted a 12 x 12 timber on the outside and a 6 x 12-in. timber on the inside, just above the water line; and the whole was bound together by four 1⅞-in. bolts extending across the crib (two each way). The lower 6 x 8-in. timbers of the cradle were carried across the crib and rested on the "walling" above mentioned, the pipe resting on these. After the pipe was laid, the crib was filled with good sized rubble rip-rap, and 3 ft. of rip-rap was placed outside of the crib.

It will be noticed that the pipe is carried across the beach at an elevation which will permit turning the sewage through a septic tank and over filter beds if at any future time it shall prove advisable to do so.

The Trusdell Ave. sewer crosses the south ravine at a place where the ravine is about 40 ft. deep, and the grade of the sewer is about 10 ft below the general level of the banks. The sewer at this point is constructed of 12-in. cast-iron pipe, carried across the ravine on an independent Fink truss, Fig. 5. There is a highway bridge at this point, but as it is rather light and has a great deal of vibration, the writer thought best to carry the sewer on a structure entirely free from such influences. There has been complaint in other towns of sewers being stopped by freezing during severe cold weather where they are exposed to the weather, as is necessary in crossing this ravine, so the writer has built around the pipe a frost case similar to those used to protect the riser pipe in elevated tanks. This is shown in Fig. 6. How far this will protect the pipe remains to be seen, as we have not yet had any severe weather to try it.

The contract for the entire system was let to Harding & Nelson, of Racine, Wis., and has been carried out faithfully and well despite much bad weather and the encountering of a large amount of unlooked for running sand and the difficulty of getting workmen. The pile and timber work of the pier and cradle, and the Fink truss frost case of the ravine crossing, were built by P. Galloway, of Racine, Wis. During the last six weeks of the work the Austin trenching machine was put on the work and proved a success.

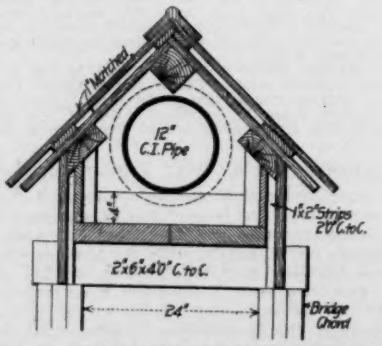
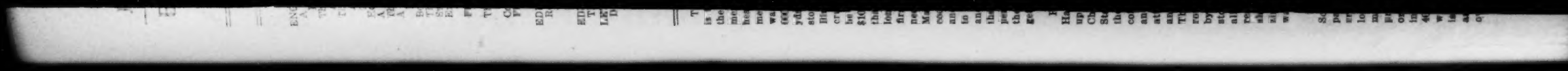



Fig. 6. Frost Casing of Outfall Sewer.